EMO--1028-Vol.9

DE92 040805

Volume 9
Removal Action System Design

March 1991
(Reissued April 1992)

Prepared for
Wright-Patterson Air Force Base
2750 Air Base Wing
Office of Environmental Management

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for Environmental Management Operations
under a Related Services Agreement
with the U.S. Department of Energy

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EXECUTIVE SUMMARY

The Phase I, Volume 9 Removal Action System Design compiles the design documents prepared for the Phase II Removal Action to be conducted at Wright-Patterson Air Force Base, Ohio. These documents, which are presented in Appendices to Volume 9, include:

- Appendix A - Process Design, which presents the 30 percent design for the ground water treatment system (GWTS).
- Appendix B - Design Packages 1 and 2 for Earthwork and Road Construction, and the Discharge Pipeline, respectively; no drawings are included in the appendix.
- Appendix C - Design Package 3 for installation of the Ground Water Extraction Well(s).
- Appendix D - Design Package 4 for installation of the Monitoring Well Instrumentation.
- Appendix E - Design Package 5 for installation of the Ground Water Treatment System; this Design Package is incorporated by reference because of its size.

Previous Phase I activities summarized in the Focused Feasibility Study (FFS) Report (Phase I, Volume 8) resulted in the selection of a removal alternative to prevent, to the extent practicable, the movement of ground water contaminated with chlorinated VOCs across the southwest boundary of Area C. Consistent with the objectives of a time-critical removal action, the investigation of ground water quality and hydrogeology under Phase I was very limited in scope. However, sufficient information was obtained to determine the existence of ground water contamination requiring near-term mitigation, to select a mitigating measure, and to develop a design for a removal alternative. The scope of the investigation did not permit development of data that could be used to predict the detailed response of the aquifer to extraction well pumping or the quality of the extracted water through time.

Rather than conduct months of additional investigation to reduce some of the uncertainty, the Observational Method approach has been employed. This approach will be implemented by constructing the entire water treatment system

(during Phase II) as designed (presented in Phase I, Volume 9), but initially installing only one extraction well. The extraction well will be pumped and water will be discharged to the treatment system. Water levels in a number of surrounding monitoring wells will be measured, and influent and effluent water quality relative to the treatment system will be monitored on a frequent basis. In addition, water quality at various locations in the aquifer will be assessed periodically through sampling and analysis. A detailed operating record of the extraction well and treatment system will also be maintained.

The design presented in the Volume 9 Removal Action Design is based on the conclusions of the FFS report, which identified air stripping as the preferred ground water treatment alternative. During the development of the treatment alternatives for the FFS, the relatively high iron content in the ground water was identified as potentially inhibiting the long-term effectiveness of the four treatment technologies identified. To enhance the effectiveness of the primary technologies, pretreatment by a conventional iron removal process was included in the process descriptions presented in the FFS.

The results of the detailed analysis in the FFS showed a clear preference for air stripping. Following the completion of the FFS, several potential air stripping technologies, including packed air stripping columns and aerated tanks, were evaluated relative to iron removal/impact. This evaluation resulted in the design of the aerated tank system without pre- or post-treatment, which is described in Section 2.0 of Volume 9.

The primary advantage of the aerated tank system over a packed-tower air column is that pretreatment to remove iron is not required. In addition, the aeration tank system is more flexible to changes in ground water flow rates than the packed column. Thus, the process design presented in Appendix A does not include treatment and/or removal of iron and calcium. Contingency plans for addressing iron and/or calcium treatment/removal are presented in the System Performance Monitoring Plan. The treatment system described in Volume 9 is capable of incorporating additional process capabilities (e.g., pH control or filtration) as needed. In accordance with the Observational Method approach employed for this design, treatment system performance data will be acquired to evaluate the need for any additional treatment provisions.

ACRONYMS

ABW	Air Base Wing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CW	Cluster Well
EMO	Environmental Management Operations
EW	Extraction Well
FIR	Field Investigation Report
FFS	Focused Feasibility Study
FS	Feasibility Study
gpm	Gallons per Minute
GWTS	Ground Water Treatment System
HSP	Health and Safety Plan
IRP	Installation Restoration Program
IT	International Technology Corporation
L	Liter
MCL	Maximum Contaminant Level
mg	Milligrams
NPL	National Priorities List
OEPA	Ohio Environmental Protection Agency
OMP	Operations and Maintenance Plan
PFD	Process Flow Diagram
P&ID	Piping & Instrumentation Diagram
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act of 1986

SOP	Standard Operating Procedures
SPMP	System Performance Monitoring Plan
TCE	Trichloroethene
TCL	Target Compound List
TEP	Test and Evaluation Plan
U.S. EPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound
WP	Work Plan
WPAFB	Wright-Patterson Air Force Base
µg	Micrograms

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1.0 INTRODUCTION

1.1 BACKGROUND

This Removal Action System Design has been prepared as a Phase I Volume for the implementation of the Phase II removal action at Wright-Patterson Air Force Base (WPAFB) near Dayton, Ohio. The objective of the removal action is to prevent, to the extent practicable, the migration of ground water contaminated with chlorinated volatile organic compounds (VOCs) across the southwest boundary of Area C. This removal action was initiated through the Installation Restoration Program (IRP) in accordance with Administrative Orders on Consent issued to WPAFB from the Ohio Environmental Protection Agency (OEPA). The Base entered into Administrative Orders on Consent with the State of Ohio on February 9, 1988 which requires compliance with State of Ohio environmental law. In October 1989, the Base was placed on the National Priorities List (NPL) by the U.S. Environmental Protection Agency (U.S. EPA). Subsequently, in March 1991, the Base entered into a Federal Facilities Agreement in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120. CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires federal installations to comply with Federal and State environmental laws and regulations.

WPAFB has retained the services of Environmental Management Operations (EMO)[(a)] and its principle subcontractor, IT Corporation (IT), to prepare the removal action design and perform the Phase II removal action. This work will be implemented with regulatory oversight and consultation from the OEPA and the U.S. EPA Region V.

The project consists of the following two major phases of work:

- Phase I - Time-critical investigation of ground water contamination at the southwest boundary of Area C and along the Springfield Pike boundary of Area B, and assessment/design of removal action technologies.

(a) EMO is operated for the Department of Energy by Battelle Memorial Institute.

- Phase II - Time-critical prevention of migration of contaminated ground water across the Area C base boundaries addressed in Phase I.

Previous Phase I activities summarized in the Focused Feasibility Study (FFS) Report (Phase I, Volume 8) resulted in the selection of a removal alternative to prevent, to the extent practicable, the movement of ground water contaminated with chlorinated VOCs across the southwest boundary of Area C. Consistent with the objectives of a time-critical removal action, the investigation of ground water quality and hydrogeology under Phase I was very limited in scope. However, sufficient information was obtained to determine the existence of ground water contamination requiring near-term mitigation, to select a mitigating measure, and to develop a design for a removal alternative. The scope of the investigation did not permit development of data that could be used to predict the detailed response of the aquifer to extraction well pumping or the quality of the extracted water through time.

Rather than conduct months of additional investigation to reduce some of the uncertainty, the Observational Method approach has been employed. This approach will be implemented by constructing the entire water treatment system (during Phase II) as designed (presented herein), but initially installing only one extraction well. The extraction well will be pumped and water will be discharged to the treatment system. Water levels in a number of surrounding monitoring wells will be measured, and influent and effluent water quality relative to the treatment system will be monitored on a frequent basis. In addition, water quality at various locations in the aquifer will be assessed periodically through sampling and analysis. A detailed operating record of the extraction well and treatment system will also be maintained.

Changes in water levels at various locations within the aquifer will be used to gain an increased understanding of the aquifer hydrology. This information will be utilized to refine the computerized ground water model of the site developed during previous Phase I activities. With the assistance of the revised model, the locations for additional extraction wells will be determined as necessary. Adjustments and modifications of the initial extraction well and the water treatment system will be made, as appropriate, based on the detailed operating record and the results of influent and effluent monitoring.

As one or more additional extraction wells are installed, re-analysis of the aquifer hydraulics and system performance will be conducted and, as necessary, additional adjustment and modifications will be made. This Observational Method approach permits initiation of the removal action in the shortest time possible and will result in an optimized and cost-effective extraction and treatment system.

1.2 DOCUMENT PURPOSE AND OBJECTIVES

As presented above, the removal action employs the Observational Method approach, which consists of four basic elements: 1) a design based on the most probable site conditions; 2) identification of reasonable deviations from those conditions; 3) identification of parameters to observe so as to detect deviations; and 4) preparation of contingency plans to address each potential deviation. This Removal Action System Design incorporates the documents prepared for the first element, design.

The design summarized in Section 2.0 is based on the most probable ground water flow rate. Influent contaminant concentrations are based on data collected during the Phase I focused field investigation and summarized in the Field Investigation Report (FIR) (Phase I, Volume 5). Reasonable deviations, as determined from modeling and analysis of the Phase I data for the FFS, were accounted for in the design of the ground water extraction and treatment system presented in the following appendices:

- Appendix A - Process Design, which presents the 30 percent design for the ground water treatment system (GWTS).
- Appendix B - Design Packages 1 and 2 for Earthwork and Road Construction, and the Discharge Pipeline, respectively; no drawings are included in the appendix.
- Appendix C - Design Package 3 for installation of the Ground Water Extraction Well(s).
- Appendix D - Design Package 4 for installation of the Monitoring Well Instrumentation.

- Appendix E - Design Package 5 for installation of the Ground Water Treatment System; this Design Package is incorporated by reference because of its size.

This Removal Action System Design is supplemented by project documents prepared for implementation of the Phase II removal action, including:

- Phase II Work Plan (WP) - summarizes the technical work scope and provides procedures required for project documentation as well as operational and logistics information for performance of the field work.
- Phase II Health and Safety Plan (HSP) - details the health and safety provisions for the Phase II scope of work.
- Test and Evaluation Plan (TEP) - details start-up procedures to test, evaluate, and optimize the operating parameters of the ground water extraction and treatment system.
- System Performance Monitoring Plan (SPMP) - details the post start-up system performance and ground water monitoring program for the ground water extraction and treatment system.
- Operations and Maintenance Plan (OMP) - details the operation and maintenance procedures for the ground water extraction and treatment system.

This Removal Action System Design is also supplemented by the quality assurance and quality control provisions of the Quality Assurance Project Plan (QAPP) for the ongoing Remedial Investigation/ Feasibility Study (RI/FS) at the Base. Standard Operating Procedures (SOPs) from the QAPP will be utilized for the project as appropriate.

1.3 DESIGN DEVELOPMENT

The design presented herein is based on the conclusions of the FFS report, which identified air stripping as the preferred ground water treatment alternative. During the development of the treatment alternatives for the FFS, the relatively high iron content in the ground water was identified as potentially inhibiting the long-term effectiveness of the four treatment technologies identified: air stripping, carbon adsorption, UV catalyzed peroxide/ozone oxidation, and aerobic fixed-film biological treatment. To enhance the effectiveness of the primary technologies, pretreatment by a con-

ventional iron removal process was included in the process descriptions presented in the FFS.

The results of the detailed analysis in the FFS showed a clear preference for air stripping. Following the completion of the FFS, several potential air stripping technologies, including packed air stripping columns and aerated tanks, were evaluated relative to iron removal/impact. The evaluation focused on process options that are least affected by iron and possibly operate successfully without removing the iron, thereby reducing the operational and cost impacts associated with separating, handling, and disposing of the iron solids/sludge that would be generated. This evaluation resulted in the design of the aerated tank system without pre- or post-treatment, which is described in Section 2.0.

The primary advantage of the aerated tank system over a packed-tower air column is that pretreatment to remove iron is not required. In an aerated tank, any oxidized iron particles are well-mixed in the water by the turbulence of the air diffusers and are entrained as suspended solids in the discharge. In the packed column, the same iron particulate tend to deposit on the packing surfaces, which greatly reduces the efficiency of the packed column. The iron deposits must either be removed prior to entering the column or after they have deposited on the packing by acid washing. In addition, the aeration tank system is more flexible to changes in ground water flow rates than the packed column. Thus, consistent with the conclusions of the FFS, the aeration tank system was developed for the Process Design (30 percent design) presented in Appendix A. Final design documents are presented in Appendices B, C, D, and E.

2.0 PROCESS DESCRIPTION

The following process description incorporates the process description presented in the Draft Process Design (Volume 9) and the 30 percent Process Design for the Extraction and Monitoring Well Network (Volume 9A). The description incorporates comments received on both of the above-referenced documents and has been modified to reflect process-related changes implemented during preparation of the final design (Design Packages 1, 2, 3, 4, and 5).

2.1 OVERVIEW

The ground water removal action combines extraction, treatment, and discharge technologies that were recommended in the FFS report as the preferred alternative for the Phase II removal action, and consists of:

- Extraction system consisting of one to three, or more, extraction wells to intercept flow of contaminated ground water.
- Ground water monitoring system consisting of water-level sensors and dedicated water-quality sampling pumps.
- Ground water treatment system (GWTS) consisting of an aerated tank system to remove VOCs from the extracted water.
- Discharge system for the treated ground water.

The following sections provide information concerning the above-listed systems.

The GWTS will be located at the southwest corner of Area C between Landfill Number 5, Prairie Road, and Riverview Road (Figure 2.1) and will consist of aerated tanks to remove VOCs from the extracted water. Air will be provided via diffusers installed in the aeration tanks to produce efficient gas-liquid contact and to achieve high removal efficiency. Air exhausted from aeration tanks will be passed through activated carbon adsorbers to remove VOCs. The detailed process is provided in Design Package No. 5 (Appendix E).

2.2 DESIGN BASIS

The nominal design capacity of the complete system is 600 gallons per minute (gpm) of ground water at 10°C containing approximately 210 micrograms

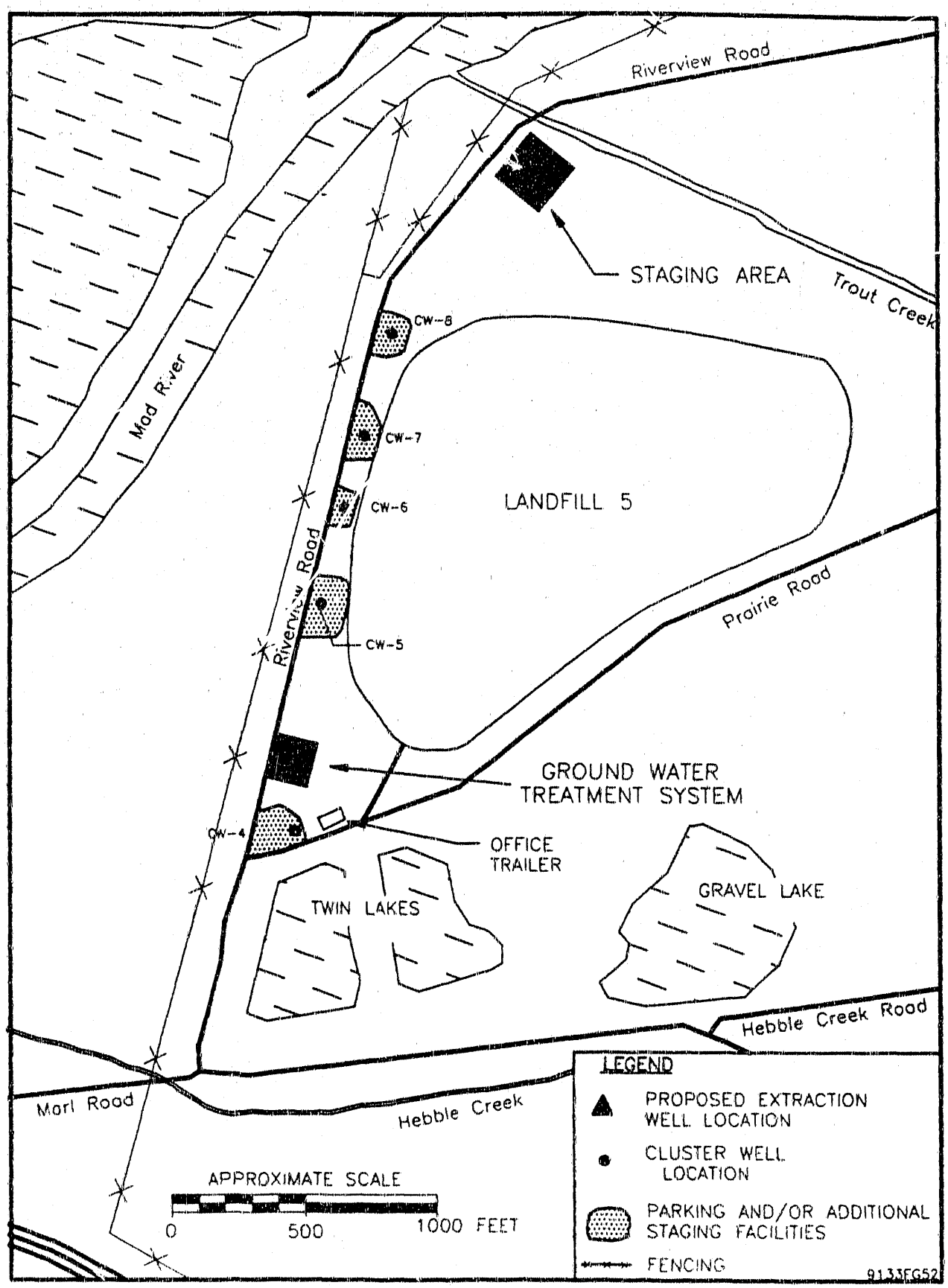

FIGURE 2.1. General Site Map

per liter (μg/L) trichloroethylene (TCE) and approximately 10 μg/L total other VOCs detected during the site investigation. Flow rate and concentration values were estimated during the FFS using results of hydrogeologic modeling and interpretation of the ground water quality data obtained from monitoring well samples collected and analyzed for the site investigation (summarized in the FIR). Ground water modeling studies also projected that the maximum flow rate necessary to achieve the removal action objective may approach 800 gpm. At this flow rate, the treatment system has a removal efficiency of greater than 95 percent.

The GWTS is designed for a maximum operating capability in excess of nominal values because the exact composition of the ground water and the required extraction pumping rate, both initially and as the removal action continues in future years, are not known. The maximum hydraulic capacity of the system is 1200 gpm, but the maximum treatable flow rate will depend on the extracted ground water composition as well as the treated effluent discharge limits.

Mineral constituents such as iron and calcium were found at maximum concentrations of approximately 30 milligrams per liter (mg/L) and 200 mg/L, respectively, in ground water samples collected during the site investigation. Given the highly oxidizing conditions expected to exist in the aeration tanks, it is anticipated that a portion of these and other dissolved solids will precipitate during the air stripping process. It is expected that most of these precipitants will remain suspended in the water being treated due to turbulence caused by aeration and, thus, will be discharged from the treatment system in the effluent.

2.3 DETAILED DESCRIPTION

2.3.1 Ground Water Extraction System

Objectives

Conditions identified during the Phase 1, Task 4 Field Investigation as documented in the FIR indicate that ground water is migrating across the southwestern boundary of Area C of Wright-Patterson AFB. Specifically, VOCs are present in ground water at concentrations exceeding acceptable criteria.

A primary objective of the focused field investigation for this project was to determine if ground water quality conditions pose a threat to human health thus requiring an immediate removal action. For the purposes of this project, ground water containing VOCs in excess of Maximum Contaminant Levels (MCLs) is assumed to require capture and treatment.

It was determined in the FFS that a system of extraction wells must be installed to prevent the contamination from leaving the Base. It is, therefore, the objective of the ground water extraction system to intercept contaminated ground water before it passes the Base boundary. While accomplishing this objective, the extraction system must neither adversely affect the level of water in Twin Lakes and Gravel Lake, nor induce excess recharge into the system from the Mad River.

Assumptions

The area of the Base requiring capture extends a length of approximately 800 to 1000 feet along the southwestern boundary of Area C extending north from near Twin Lakes. The area includes Phase 1, Task 4 monitoring well clusters CW-4, CW-5, and CW-6, with the highest VOC concentrations identified in cluster well CW-5 (Figure 2.1). VOCs were identified in cluster wells CW-4 through CW-6 at all depths within the aquifer, which has a saturated thickness of approximately 80 feet.

The extraction system design is based on a computer simulation of the aquifer. The model used is GWFL3D (Walton, 1989), which is an interactive version of PLASM (Prickett and Lonnquist, 1971). Several assumptions were made to facilitate model development, including:

- The regional potentiometric map of March 1988 represents current aquifer conditions.
- The Mad River is a gaining stream in the vicinity of Area C of the Base.
- Porous flow equivalents are valid characterizations for composite transmissive zones in the aquifer stratigraphy.
- Bedrock boundaries surrounding the Mad River Aquifer are "no flow" boundaries.

Justification for these assumptions is presented in the FFS.

Approach

For the purposes of implementation, the extraction wells will be located and installed using the Observational Method approach; that is, the performance of the extraction well system will be assessed periodically. If the program objectives are not being achieved, the system will be modified to meet the objectives.

Modeling simulations in the FFS indicate that a single well pumping 600 gallons per minute (gpm) will be adequate to intercept the ground water crossing the Base boundary. These simulations also indicate that several wells installed as a linear array parallel to the Base boundary will result in better control of ground water movement and minimize influences on the Mad River, Twin Lakes, and Gravel lake. These conclusions about the effectiveness of the extraction system are based on the assumptions presented above. The available data are preliminary in nature, and unknown boundary conditions may alter the observed versus modeled effects of the extraction system.

To overcome the uncertainties, the extraction well system will be installed in stages in accordance with the Observational Method approach. Initially, one well (extraction well EW-1) will be placed at the location of cluster well CW-5. This well will be capable of pumping 600 to 800 gpm from the entire saturated thickness of the aquifer. During pumping, water-level changes will be observed in 26 monitoring wells. The changes will be evaluated to calculate the aquifer characteristics of transmissivity and storativity.

Newly acquired data will be used as calibration input for the computer model. Using the re-calibrated model, the extraction system performance will be evaluated, if necessary. Additional extraction wells will be located and installed or pumping rates will be adjusted to meet the objectives of the program.

After new wells are added or the flow rate is adjusted, the impact on the aquifer will be observed and the model will be adjusted again. Model simulations will be used to fine-tune the system to achieve all objectives. It is estimated that the adjustment and refinement process will take place over a one year period.

Design

Available information indicates that one to three extraction wells will be acceptable to achieve the project objectives. Extraction Well EW-1 will be located adjacent to cluster well CW-5 shown on Figure 2.1. Any additional wells will be installed pending analyses of data, in accordance with the Observational Method approach.

The wells will be installed using standard drilling techniques (hollow-stem auger for the test boring and cable-tool for the extraction well). The borehole will be extended to bedrock (anticipated to be less than 100 feet below grade). The well assembly will be installed in the borehole.

A fully penetrating well screen and artificial gravel pack will be installed. The gravel and slot size will be selected to reflect aquifer conditions. Slot sizes, therefore, may vary with depth in response to actual lithologic conditions.

Following installation and development, the well will be equipped with a pump capable of delivering the required quantity of water. To influence the entire aquifer thickness, the pump intake will be placed at the bottom of the well screen. All motor and electrical controls will be mounted above the 25-year flood elevation.

Specifics of the well design (e.g., borehole size, screen diameter, etc.) may vary between the first well (EW-1) and subsequent wells. The variation will reflect the change in yields needed to meet all program objectives.

2.3.2 Treatment System

Ground water from the well pump(s) will enter the first aeration tank into which air will be sparged to strip the VOCs. The aeration tank will be subdivided by baffles into three equal-volume chambers (or stages), with fine bubble diffusers arranged across the entire bottom surface of each chamber. Air will be delivered to diffusers by aeration blowers. The approximate operating water level in all the chambers will be the same (5.5 feet), and will be controlled by a level controller in the degas tank. The hydraulic residence time in each chamber of the aeration tank will be about 7 minutes

based on an influent flow rate of 600 gpm. The total residence time in the first aeration tank will be approximately 22 minutes. At a flow rate of 800 gpm, the residence time in each stage is approximately 5.5 minutes, yielding a removal efficiency of 95 percent, which is used for the material balance presented on the process flow diagram (PFD) in Section 11.0 of the Process Design (Appendix A).

During start-up, the well pumping rate may need to be decreased to accommodate higher than nominal influent concentrations. Initial concentrations of chlorinated VOCs in the extracted water may be higher until steady state conditions are achieved due to high concentrations of these compounds in the immediate area of EW-1. The air flow rate will remain constant during start up.

Air from the first two chambers will exhaust through demisters to remove entrained water droplets. Water collected in the demisters will drain back into their respective chambers. The combined air flow from the first two chambers will be drawn through an exhaust blower and passed through two vapor-phase carbon adsorbers in series to remove VOCs prior to venting to the atmosphere. Air exhausted from the third chamber of the aeration tank will be vented to the atmosphere because this exhaust is projected to contain an insignificant quantity of VOCs. This discharge is in accordance with Ohio Administrative Code rule 3745-21-07(G)(2), which allows VOC discharges of 8 pounds per hour and 40 pounds per day from a stationary source. The exhaust blower will be automatically controlled to maintain atmospheric pressure at the top of the chambers. The blower provides for the pressure drop across the demisters and the vapor-phase carbon adsorbers.

Water will flow from the third chamber of the first aeration tank into the first chamber of the second aeration tank. This tank is similar in design to the first aeration tank and provides three additional chambers of stripping and an additional 22 minutes hydraulic residence time at a flow rate of 600 gpm. Air will be sparged into aeration diffusers using aeration blowers.

Provisions have been made to enable either of the two aeration tanks to operate as a stand-alone unit in the event that one unit is off-line due to maintenance or for any other reason. The vents from the first two chambers of

the second aeration tank can be manually diverted to the exhaust blower and vapor-phase carbon adsorbers if this tank is used alone.

Periodically, when analysis of the discharge from the lead carbon adsorber indicates breakthrough of organic contaminants has occurred, the lead carbon adsorber will be replaced with a unit containing fresh carbon. At this changeout time, discharge from exhaust blowers will be switched to pass through only the polishing adsorber by manually positioning valves to and from each adsorber. The polishing adsorber will serve as the lead unit until the next changeout. The spent carbon unit will be disconnected from the inlet and outlet vapor lines, removed, and placed on a truck provided by the carbon vendor. The replacement unit will be unloaded, placed in position, and the manual valves positioned such that the new unit serves as the polishing adsorber. The spent carbon units will be transported off site to a commercial regeneration facility.

Treated water will flow by gravity from the second aeration tank into the degas tank. In the degas tank the air bubbles will disengage from the water prior to entering the treated water discharge pumps. One discharge pump will normally operate up to the maximum design flow; the second pump will serve as an installed spare that will turn on automatically if an abnormally high-level (water depth) condition exists, such as from failure of the primary pump or if the influent flow to the GWTS exceeds the capacity of the primary pump.

The water level in the entire system will be controlled by a level control system in the degas tank. Because flow is unrestricted between tanks, the level in all of the tanks will be approximately equal. Therefore, a change in level in the degas tank would, under normal conditions, be equal to a change in level in the aeration tanks. The control system will adjust the pump speed of the variable frequency drive discharge pumps to control tank levels, as noted on Drawing E12 in Design Package 5 (Appendix E). The level control system will also activate an alarm and turn off the entire system (including the extraction well pumps) at the high-high setting, and activate an alarm and turn off the primary discharge pump at the low-low setting.

No separate storage tanks are provided for water before or after treatment. However, the excess capacity of the aeration tanks provides some storage to accommodate any short-term or rapid change in influent flow rate.

The treatment system has the capability of operating effectively at flow rates much lower than the nominal 600 gpm. These lower flows might be expected during the initial operation with the first extraction well. Lower flows would result in proportionally longer residence times in each of the aeration tanks and the degas tank. Air flow rates to each chamber in the aeration tanks will be 500 acfm. This flow rate could be reduced by mechanically changing the drive or the motor for the blower, if desired. Recycle lines from both aeration tanks enable trial operation of the GWTS with no (or very low) influent flow rates from the wells (such as during start-up and test and evaluation). With no influent flow, one or both of the aeration tanks could be operated in the recycle mode without any discharge from the GWTS to the river.

Water flow from the treatment system pad sump pump may be manually controlled to discharge to any of the three tanks: the East Aeration tank, the West Aeration tank, or the Degas tank. Normal flow will be to the East Aeration tank. Flow may be diverted to the West Aeration tank if the East Aeration tank is out of service (e.g., for maintenance). Flow may be passed directly to the Degas tank if the extraction system is not functioning (i.e., the system is not treating water) and the aeration tanks are being cleaned at the same time. In this event, only uncontaminated water (e.g., rain water) collected in the sump would be discharged, and the water will be sampled and analyzed for discharge parameters before being pumped to the Degas tank.

The process design presented in Appendix A does not include treatment and/or removal of iron and calcium. Contingency plans for addressing iron and/or calcium treatment/removal are presented in the System Performance Monitoring Plan. Potential problems of equipment fouling and suspended solids as well as potential alternative approaches were considered in the identification, evaluation, and selection of potential treatment technologies, as summarized in the FFS. The treatment system described herein is capable of incorporating additional process capabilities (e.g., pH control or filtration) as needed. In accordance with the Observational Method approach employed for

this design, treatment system performance data will be acquired to evaluate the need for any additional treatment provisions.

2.3.3 Discharge System

Using the treated water discharge pumps, the treated water from the degas tank will be transferred approximately 3000 feet through a discharge pipeline to an outfall at the Mad River. The pipeline routing is generally north along the alignment of Riverview Road, as shown in Design Packages 1 and 2.

2.3.4 Treatment System Monitoring Provisions

To monitor the performance of the ground water treatment system, the system is equipped with monitoring instruments such as pressure, flow, level, and temperature sensors/transmitters, as listed in Section 6.0 and summarized in Section 7.0 of the Process Design (Appendix A). The locations of the instruments and the system operating conditions are shown on the piping and instrument diagrams (P&IDs) in Section 12.0 of the Process Design (Appendix A). In addition, sample valves are identified on the P&IDs for monitoring air and water concentrations at various stages of the treatment process.

The treatment system instruments and sampling locations will be utilized during the test programs presented in the Test and Evaluation Plan and the System Performance Monitoring Plan. Further information concerning the instruments are presented in the Operations and Maintenance Plan.

2.3.5 Water-Level/Water-Quality Monitoring System

Objective

The objective of the extraction system is to control off-site migration of ground water from the southwestern boundary of Area C. To assure that this objective is achieved, a monitoring system will be installed and operated to provide the data that will allow adjustment in extract system operation.

Assumptions

The major assumption affecting the design of the ground water monitoring program of this extraction system is that little, if anything, is known about the quality of ground water upgradient of the extraction system. As a result,

changes in quality of water in the extraction wells or monitoring wells may not reflect the effectiveness of the program. The primary objective of the extraction system is to intercept and collect all affected ground water crossing the southwestern boundary of Area C.

Approach

A two part monitoring system will be employed: 1) water-level monitoring, and 2) water-quality monitoring. The water-level monitoring system will be the primary system to assess the effectiveness of the extraction system. Water-level data can be quickly evaluated to demonstrate that the extraction system is intercepting all water passing the Base boundary in the area of concern.

Existing monitoring wells representing all aquifer depths will be identified for inclusion in the water-level monitoring program. The wells will be located within the area of influence of the extraction well system.

Figure 2.2 shows the capture zone, as defined by the one-foot drawdown contour. The figure also identifies the 26 water-level monitoring wells within and around the effected area. An automated water-level recording system will be installed in each well for collection and transmittal of data.

To identify water-quality trends, 18 wells (shown on Figure 2.2) will be sampled on a quarterly schedule. Samples will be analyzed for Target Compound List Volatile Organic Compounds (TCL VOCs).

Design

Water-Level Monitoring. Each of the 26 identified wells will be equipped with a pressure transducer connected to a data logger. The transducer will be capable of collecting data at a range of preset intervals. Specific intervals will be determined to reflect the initial start-up phases and long-term, steady-state monitoring.

The transducers will be connected via land line to a central control unit located at the water-treatment facility. From there, the control unit can be accessed via telephone from a computer terminal.

Two different types of data analyses will be conducted. During the start-up phases, the water-level data will be evaluated using standard com-

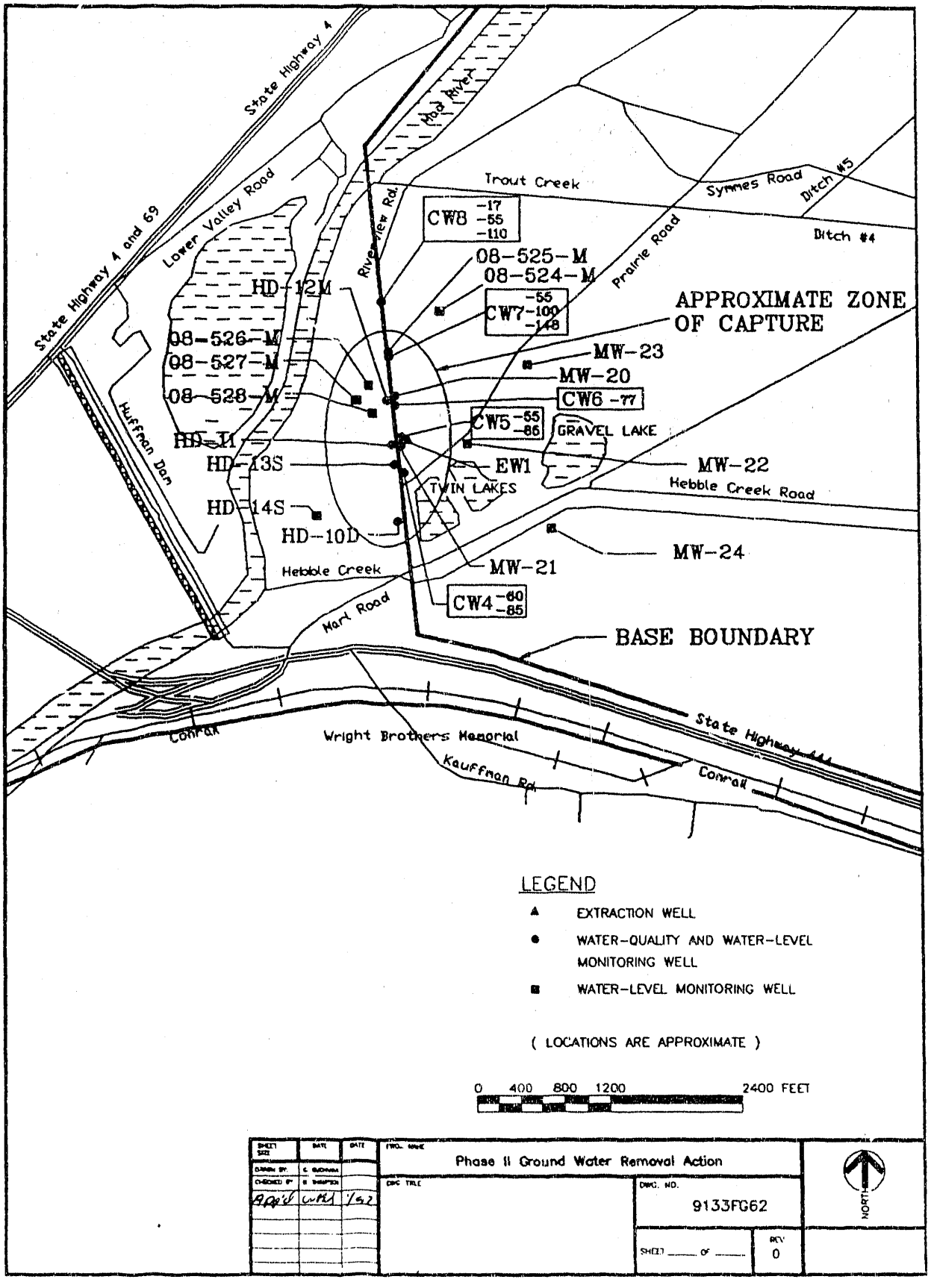

FIGURE 2.2. Existing Monitoring Well Locations and Approximate Capture Zone

puter contouring techniques to identify the potentiometric surfaces within the zone of impact of the wells. Using these contours, pumping rates will be adjusted to insure that the one-foot contour extends beyond the primary capture zone at the property line. During long-term operations, this same analysis will be made periodically to assure that the system is operating acceptably.

Water-Quality Monitoring. Water-quality samples will be collected quarterly from 18 monitoring wells shown on Figure 2.2 following the RI/FS QAPP Standard Operating Procedures (SOPs) for this activity. Samples will be analyzed for TCL VOCs using the RI/FS SOPs.

3.0 REFERENCES

Barge, Waggoner, Sumner, and Cannon, April 1991, Design Packages Numbers 1 and 2, Miamisburg, Ohio.

Barge, Waggoner, Sumner, and Cannon, July 1991, Design Packages Number 5, Miamisburg, Ohio.

Engineering Science, 1989, Project Work Plan for Remedial Investigations and Feasibility Studies at Wright-Patterson Air Force Base, Ohio, Volumes 1 through 4, Dayton, Ohio.

IT Corporation, June 1990, Work Plan for Task 4, Volume 2, Cincinnati, Ohio.

IT Corporation, November 1990, Field Investigation Report, Volume 5, Cincinnati, Ohio.

IT Corporation, November 1990, Proposed Removal Action Alternatives, Volume 6, Knoxville, Tennessee.

IT Corporation, November 1990, Technology Plan, Volume 7, Knoxville, Tennessee.

IT Corporation, January 1991, Focused Feasibility Study, Volume 8, Knoxville, Tennessee.

IT Corporation, March 1991, Draft Process Design, Volume 9, Knoxville, Tennessee.

IT Corporation, May 1991, Design Package 3 - Ground Water Extraction Wells, Cincinnati, Ohio.

IT Corporation, May 1991, Design Package 4 - Monitoring Well Instrumentation, Cincinnati, Ohio.

IT Corporation, May 1991, Draft Phase II Health and Safety Plan, Cincinnati, Ohio.

IT Corporation, May 1991, Draft Phase II Work Plan, Cincinnati, Ohio.

IT Corporation, October 1991, Draft Operations and Maintenance Plan, Cincinnati, Ohio.

IT Corporation, October 1991, Draft System Performance Monitoring Plan, Cincinnati, Ohio.

IT Corporation, October 1991, Draft Test and Evaluation Plan, Cincinnati, Ohio.

Prickett, T. A., and Lonnquist, C. G., 1971, Selected Digital Computer Techniques for Ground Water Resource Evaluation, Bulletin 55. Illinois State Water Survey, Champaign, Illinois.

Walton, William C., 1989, Ground Water Pumping Tests: Design and Analysis, Lewis Publishers, Inc., Chelsea, Michigan.

Walton, William C., 1989, Numerical Ground Water Modeling: Flow and Contaminant Migration, Lewis Publishers, Inc., Chelsea, Michigan.

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APPENDIX A

PROCESS DESIGN

The enclosed Process Design -- which was originally issued on March 20, 1991, has been revised to include comments from the Ohio Environmental Protection Agency and the U.S. Environmental Protection Agency.

INSTALLATION RESTORATION PROGRAM

ENVIRONMENTAL INVESTIGATION OF GROUND WATER CONTAMINATION AT WRIGHT-PATTERSON AIR FORCE BASE, OHIO

VOLUME 9
PROCESS DESIGN

Submitted by:

BATTELLE ENVIRONMENTAL
MANAGEMENT OPERATIONS
DAYTON, OHIO

Submitted to:

WRIGHT-PATTERSON AIR FORCE BASE
2750 AIR BASE WING
OFFICE OF ENVIRONMENTAL MANAGEMENT
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

Prepared by:

IT CORPORATION

KNOXVILLE, TENNESSEE
CINCINNATI, OHIO

March 20, 1991

Revised January 31, 1992

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WPAFB, OHIO

PROCESS DESIGN MANUAL

AREA 20
GROUNDWATER TREATMENT SYSTEM

TABLE OF CONTENTS

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FOREWORD

This volume contains the results of the project work phase known as process design engineering. The objective of the process engineering phase is to take an early conceptual process definition and provide the initial engineering and documentation to permit subsequent detailed design engineering to proceed most effectively. Detailed design engineering involves developing design drawings and specifications adequate to construct the facility. Process engineering is documented in the form of a Process Design (PD). A PD typically contains those elements listed in the Table of Contents. A general description of each process design element is provided below.

Process Description (Section 2.0):
A process description is a description of the overall operation of the process. It describes step-by-step the flow of materials through the process, the function of major process components and control systems, and defines the design basis for the process. The process description provides operations personnel a basis for writing operating instructions.

Equipment List (Section 3.0):
The equipment list provides an itemized listing and brief description of all equipment included in the system.

Equipment Specifications (Section 4.0):
The process-specific features required for individual items of equipment are provided on Equipment Specification sheets. Features that are included are performance (duty) requirements and sometimes mechanical requirements. Equipment Specifications serve as a guide to the detail designer to prepare detailed drawings, specifications for fabricated items, or to select vendors and obtain quotes for off-the-shelf items. During the process design phase, only duty and selected key features are normally established, with additional features completed during detailed design.

Pipe Line List (Section 5.0):
Pipe Line Lists are used to list information that identifies and describes the specifications and operating conditions of each pipe line shown on the Process and Instrumentation Diagrams (P&ID's).

Instrument List (Section 6.0):
Instrument Lists are a tabulation of all individual elements of all instrument systems. All sensing instruments, control valves, safety devices, etc. are assigned unique instrument numbers. The list

identifies the instrument's location, service, and number. This index is very useful during the procurement and construction activities.

Instrument Data Summary Sheet (Section 7.0):
Instrument Data Summary Sheets are a record of various information, such as normal and maximum pressure and temperature, relating to the service requirements for each instrument identified in the Instrument List. The specific type of instrument may be established during the process design or the detailed design.

Process Control Description (Section 8.0):
The purpose of the Process Control Description is to describe how the control systems (loops) during normal and abnormal operation. The logic of the control system (or loop) is discussed as well as the function of each component of instrumentation comprising each system. Instruments that do not perform process control functions are not included in this section.

Logic Diagrams (Section 9.0):
The function of the logic diagram is to supplement information on the Process Flow Diagrams (PFDs) and P&IDs for the automated shutdown systems (interlocks) in sufficient detail for instrumentation and electrical design. The logic diagram conveys the information to the designer regarding what each shutdown system is supposed to accomplish.

Drawing List (Section 10.0):
Drawing Lists provide an itemized listing of all drawings prepared for the process design.

Process Flow Diagrams (Section 11.0):
PFDs provide a simplified summary of the process elements in pictorial form. PFDs show all equipment, process flows, major process control systems (loops), and a material balance. The material balance is a chart showing the quantities and key conditions of process streams throughout the system.

Piping and Instrumentation Diagrams (Section 12.0):
P&IDs are a detailed diagrammatic representation of all equipment, piping, and instrumentation required for a processing system. These diagrams collectively represent a detailed version of the PFDs. All equipment, piping, and instrument components are identified with unique numbers that correspond to the lists, specifications, and other elements of the PD.

Plot and Equipment Arrangement Plans (Section 13.0):
Plot plans show the approximate location of the new process area, access to the area, buildings and major structures relative to existing site features. Equipment arrangement plans show approximate

location of the process equipment, major pipelines, etc. within the defined process area. Some approximate dimensions are also included on both types of drawings.

Electrical One-line Diagram (Section 14.0):

Electrical One-line Diagrams are analogous to the process flow diagrams. An electrical engineer uses this diagram to represent, in a simplified manner, the flow of electric power from a source to each user (motors, lighting, control center, etc.).

LIST OF ACRONYMS

ACFM	Actual cubic feet per minute
APD	automatic phone dialer
CPVC	copolyvinyl chloride
FFS	Focused Feasibility Study
FRP	fiber-reinforced plastic
gpm	gallons per minute
GWTS	ground water treatment system
HP	horsepower
MCL	maximum contaminant level
mg/l	milligrams per liter
OSHA	Occupational Safety and Health Administration
PD	Process Design
PFD	process flow diagram
P&ID	piping and instrumentation diagram
psig	pounds per square inch (gauge)
PVC	polyvinyl chloride
TCE	trichloroethylene
TEFC	totally enclosed fan cooled
VCH	volatile chlorinated hydrocarbons
WPAFB	Wright-Patterson Air Force Base
µg/l	Micrograms per liter

LIST OF REFERENCES

IT Corporation, "Field Investigation Report", Volume 5, Cincinnati, Ohio, November 1990.

IT Corporation, "Focused Feasibility Study", Volume 8, Knoxville, Tennessee and Cincinnati, Ohio, February 1991.

IEEE, "Recommended Practice for Electric Power Distribution for Industrial Plants", Std. 141, 1976.

2.0 PROCESS DESCRIPTION

2.1 OVERVIEW

The process described in this Process Design (PD) is a complete system for the extraction, treatment and discharge of a portion of the ground water flowing across the southwest boundary of Area C at Wright-Patterson Air Force Base (WPAFB), Ohio. This ground water treatment system (GWTS) serves as a removal action to prevent, to the extent practicable, the off-site migration of ground water containing volatile chlorinated hydrocarbons above applicable maximum contaminant levels (MCLs) as identified during site investigation activities (as documented in Phase I, Volume 5). The system described herein provides the combination of extraction, treatment, and discharge technologies that were recommended in the Focused Feasibility Study (FFS) Report (Phase I, Volume 8) as the preferred alterative for this removal action.

The GWTS will consist of one to three or more extraction wells installed just inside the subject boundary (eastern side of Riverview Road) to intercept the flow of ground water in which concentrations of volatile chlorinated hydrocarbons (VCHs) exceed the applicable MCLs. Well pumps will continuously transfer the ground water to the treatment system located in the southwest corner of Area C between Landfill Number 5, Prairie Road, and Riverview Road. Air stripping will be used to remove the VCHs. Diffusers installed in a series of aeration tanks will provide sufficient air to produce efficient gas-liquid contacting and achieve high removal efficiency. Air exhausted from the aeration tanks will be passed through activated carbon adsorbers to remove the volatile chlorinated hydrocarbons. The treated water will be pumped continuously to a proposed on-site outfall at the Mad River.

2.2 DESIGN BASIS

The nominal design capacity of the complete system is 600 gallons per minute (gpm) of ground water at 10° C containing approximately 210 micrograms per liter (μg/l) trichloroethylene (TCE) and approximately 10 μg/l total other VCHs detected during the site investigation. These flow rate and concentration values were estimated during development of the FFS (Phase 1, Volume 8) using the results of hydrogeologic modeling and interpretation of the ground water characterization data obtained from monitoring wells during the site investigation (Phase 1 Volume 5).

Ground water modeling studies also projected that the maximum flow rate that might be necessary to achieve the removal action objective was 800 gpm. At this flow rate the treatment system has a removal efficiency of greater than 95 percent. Typically the nominal design values of flow rate and concentration are used to develop the material balance for the treatment system; however, the maximum flow rate was used instead to demonstrate the mass flow conditions in the system at the maximum projected flow. The material balance is included as part of the Process Flow Diagram (PFD) located in Section 11.0 of this PD.

The GWTS has been designed for a maximum operating capability in excess of the nominal values because the exact composition and flow rate to be extracted, both initially and as the removal action continues in future years, are not known. The maximum hydraulic capacity of the system is 1200 gpm but the maximum treatable flow rate will depend on the extracted ground water composition as well as the treated effluent discharge limits (not currently established). Ground water containing higher concentrations of VCHs than the projected nominal value (220 μg/l) could be treated. A higher removal efficiency, if required to maintain the effluent concentration below the discharge criteria, could be achieved by decreasing the flow rate.

Mineral constituents such as iron and calcium were found at maximum concentrations of about 30 milligrams per liter (mg/l) and 200 mg/l, respectively. Although these minerals tend to precipitate out of the water during the air stripping process, most of the resulting particulate will be well mixed with the water due to the turbulence caused by the aeration and will be discharged from the treatment system in the effluent.

2.3 DETAILED DESCRIPTION

Refer to the Process Flow Diagram in Section 11.0.

2.3.1 Extraction System

The extraction well system will be implemented using a staged approach. Initially, a single well (Extraction Well EW-1) will be installed in the center of the intercept area (near existing Cluster Well CW-5). The well will be constructed in a manner comparable to production (water supply) wells that have been installed in the region. The well will be drilled to the top of bedrock and wire-wrapped well screens will be installed to draw ground water from the entire saturated thickness of the aquifer. The well screen material will be selected as part of the detail design. The screened intervals and well screens will be selected based on the grain size distribution of aquifer samples taken during drilling.

A turbine pump (P-2001) will transfer water about 500 feet through an underground pipeline to the treatment system. The maximum capacity of this pump is expected to be 600 gpm; the pumping rate will be adjusted manually to accomplish the desired drawdown of the water table. Adjustments will be done by periodically measuring the depth to ground water and setting the position of a manual throttling valve located at the pump. The flow rate from the well will be measured at the treatment system location. During a trial period of several weeks, ground water levels will be measured in nearby monitoring wells within the intended intercept area to establish aquifer response to pumping. During this period, the appropriate pumping rate will be established and, if necessary, the pump may be exchanged for a different capacity pump. Time-sequence water-level data will be used to refine the current understanding of aquifer characteristics and permit recalibration of the existing ground water flow model.

A decision on where and what type/capacity of additional extraction wells will be made using the recalibrated ground water flow model. For the purpose of this process design, two wells (Extraction Well EW-2 and EW-3) and corresponding well pumps (P-2004 and P-2005) are designated. These two turbine pumps have been sized for this design at 400 gpm maximum each, although pumps having different capacities may actually be installed depending on the modeling results. These additional wells will pump water through separate underground pipelines to the treatment system. Separate lines will prevent ground water from one well entering another well, even under abnormal operating conditions. The flow rate from these two wells will be measured at the treatment system location.

After all necessary wells have been installed and developed, the pumping rate at each well will be adjusted to achieve the most efficient interception. This adjustment may require replacement and/or modification of some or all of the initially installed pumps. The combined capacity of the wells that are ultimately used will not exceed the hydraulic design limits of the GWTS.

2.3.2 Treatment System

Ground water from the well pumps will enter the Primary Aeration Tank (T-2001) into which air will be sparged to strip the VCHs. The tank will be subdivided by baffles into three equal volume chambers (or stages) with fine bubble diffusers arranged across the entire bottom surface of each stage. Air will be delivered to the Primary Diffusers (Z-2001 A-C) by Aeration Blowers (B-2001 A-C). The air flow rate will be set at 500 acfm at 100° F and 100% relative humidity (R.H.), producing a total air flow rate into the system of 3000 acfm. The flow rate will be measured at the blowers. The approximate operating water level in all the stages will be the same (5.5 feet), and will be controlled by a level controller in the Degas Tank (T-2003). The level control loop will be described later in this section. The hydraulic residence time in each stage of T-2001 will be about 7 minutes based on a combined nominal well pumping flow rate of 600 gpm; total residence time in T-2001 will be about 22 minutes. At a flow rate of 800 gpm, the residence time in each stage is approximately 5.5 minutes, yielding a removal efficiency of 95 percent, which is used for the material balance presented on the PFD in Section 11.0. During startup, the well pumping rate may need to be decreased to accommodate higher than nominal influent concentrations. Initial concentrations may be higher until steady state conditions are achieved due to the presence of high concentrations in the immediate area of the pumping well. Air flow rate would remain constant during start-up since there would be no advantage to decreasing the flow from the constant maximum flow rate of 500 cfm.

Air containing VCHs will exhaust from the first two chambers through Primary Demisters (Z-2003 A,B) to remove entrained water droplets. Water collected in the demisters will drain back into their respective stages. The combined air flow from the first two stages will be drawn through Exhaust Blowers (B-2003 A,B) and passed through two Vapor-Phase Carbon Adsorbers (C-2001 A,B) in series to remove VCHs prior to venting to the atmosphere. The Exhaust Blowers (B-2003 A,B) will be automatically controlled to maintain atmospheric pressure at the top of these two stages. These blowers provide for the pressure drop across

the Primary Demisters (Z-2003 A,B) and the Vapor-Phase Carbon Adsorbers (C-2001 A,B). Air exhausted from the third stage of T-2001 will be vented to the atmosphere via a common stack because it is projected to contain an insignificant quantity of VCHs. This discharge is in accordance with Ohio Administrative Code rule 3745-21-07(G)(2), which allows VCH discharges of 8 pounds per hour and 40 pounds per day from a stationary source.

Water will underflow from the third stage of the Primary Aeration Tank (T-2001) and flow into the Secondary Aeration Tank (T-2002). This tank is exactly the same design as T-2001 and provides three additional stages of stripping and an additional 22 minutes hydraulic residence time at the flow rate of 600 gpm. Air will be sparged into Secondary Aeration Diffusers (Z-2002 A-C) using Secondary Aeration Blowers (B-2002 A-C). The conditions in the Secondary Aeration Tank will be comparable to those in the Primary Aeration Tank. Similar to air exhausted from the final stage of the Primary Aeration Tank, air exhausted from all three stages of the Secondary Aeration Tank will normally be vented to the atmosphere because this exhaust is projected to contain an insignificant quantity of VCHs. Direct discharge of the air exhausted from the last four of the six total stripping stages will reduce carbon consumption (resulting from more dilute concentrations of VCHs in the exhaust from the tanks) and, therefore decrease the frequency of carbon replacement.

Provisions have been made to enable either aeration tank to operate as a stand-alone unit in the event that one unit is off-line due to maintenance or other reasons. The vents from the first two stages of the Secondary Aeration Tank (T-2002) can be manually directed to the Exhaust Blowers (B-2003 A,B) and Vapor-Phase Carbon Adsorbers (C-2001 A,B) if T-2002 is used alone.

Periodically, when analysis of the discharge from the lead carbon adsorber indicates breakthrough of organic contaminants has occurred, the lead carbon adsorber will be replaced with a unit containing fresh carbon. At this changeout time, discharge from Exhaust Blowers (B-2003 A,B) will be switched to pass through only the polishing adsorber by manually positioning valves to and from each adsorber. The polishing adsorber will serve as the lead unit until the next changeout. The spent carbon unit will be disconnected from the inlet and outlet vapor lines, and removed and placed on a truck provided by the carbon vendor. The replacement unit will be unloaded, placed in position, and the manual valves positioned such that the new unit serves as the polishing adsorber. The spent carbon units will be transported off site to a commercial regeneration facility.

Treated water will flow by gravity from the Secondary Aeration Tank (T-2002) into the Degas Tank (T-2003). In the Degas Tank the air bubbles will disengage from the water prior to entering the Treated Water Discharge Pumps (P-2003 A or B). One discharge pump will normally operate up to the maximum design flow; the second pump will serve as an installed spare that will turn on automatically if an abnormally high level condition exists such as from failure of the primary pump or if the influent flow to the GWTS exceeds the capacity of the primary pump.

The water level in the entire system is controlled by a level control system in the Degas Tank. Because flow is unrestricted between tanks, the level in all of the tanks will be approximately equal. Therefore, a change in level in the Degas Tank would, under normal conditions, be equal to a change in level in the Aeration Tanks. The control system will adjust the position of the control valve at the outlet of the discharge pumps to open more at high levels and close more at low levels. The level control system will also activate an alarm and turn off the entire system at the high-high setting, and activate an alarm and turn off the primary discharge pump at the low-low setting.

No separate storage tanks are provided for water before or after treatment. However, the excess capacity of the aeration tanks provides some storage to accommodate any short-term or rapid change in influent flow rate.

The treatment system has the capability of operating effectively at flow rates much lower than the nominal 600 gpm. These lower flows might be expected during the initial operation with the first extraction well. Lower flows would result in proportionally longer residence times in each of the Aeration Tanks and the Degas Tank. Air flow rates to each stage in the Aeration Tanks will be 500 acfm. This flow rate could be reduced by mechanically changing the drive or the motor for the blower, if desired. Recycle lines from both Aeration Tanks enable trial operation of the GWTS with no (or very low) influent flow rates from the wells (such as during startup and shake-down). With no influent flow, one or both of the Aeration Tanks could be operated in the recycle mode without any discharge from the GWTS to the river.

Water flow from the treatment system pad sump pump may be manually controlled to discharge to any of the three tanks: the Primary Aeration tank, the Secondary Aeration tank, or the Degas tank. Normal flow will be to the Primary Aeration tank. Flow may be diverted to the Secondary Aeration tank if the Primary Aeration tank is out of service (e.g., for maintenance). Flow may be passed directly to the Degas tank if the extraction system is not functioning (i.e., the system is not treating water) and the aeration tanks are being cleaned at the same time. In this event, only uncontaminated water (e.g., rain water) collected in the sump would be discharged, and the water will be sampled and analyzed for discharge parameters before being pumped to the Degas tank.

The process design presented herein does not include treatment and/or removal of iron and calcium. Contingency plans for addressing iron and/or calcium treatment/removal are presented in the System Performance Monitoring Plan. Potential problems of equipment fouling and suspended solids as well as potential alternative approaches were considered in the identification, evaluation, and selection of potential treatment technologies, as summarized in the Volume 8 Focused Feasibility Study. The treatment system described herein is capable of incorporating additional process capabilities (e.g., pH control or filtration) as needed. In accordance with the Observational Method approach employed for this design, treatment system performance data will be acquired to evaluate the need for any additional treatment provisions.

2.3.3 Discharge System

The treated water from the Degas Tank will be transferred using the Treated Water Discharge Pumps (P-2004 A or B) approximately 3000 feet through a new underground pipeline to an outfall proposed to be located on-Base at the Mad River. The pipeline routing is expected to lead north along Riverview Road inside the Base property line. The exact location of the proposed outfall and pipeline routing as well as the design of the outfall will be established during the detailed design phase.

2.3.4 Monitoring Provisions

To monitor the performance of the ground water treatment system, the system is equipped with monitoring instruments such as pressure, flow, level, and temperature sensors/transmitters, as listed in Section 6.0 and summarized in Section 7.0. The locations of the instruments and the system operating conditions are shown on the P&IDs in Section 12.0. In addition, sample valves are identified on the P&IDs for monitoring air and water concentrations at various stages of the treatment process.

The treatment system instruments and sampling locations will be utilized during the test programs presented in the Test and Evaluation Plan and the System Performance Monitoring Plan. Further information concerning the instruments are presented in the Operations and Maintenance Plan.

3.0 EQUIPMENT LIST

The equipment list provides an itemized listing and brief description of all major equipment related to the GWTS. The list includes the equipment number (defined below), name, quantity, a description of the main features necessary for selecting a particular equipment item, the capacity of the equipment (i.e. flow rate, volume, etc.), and the PFD and P&ID drawing number designation. This information, presented in tabular form, is a convenient reference for the detail designer and system operator for specifying and locating each piece of equipment.

3.1 NUMBERING SYSTEM

The following numbering system for equipment was used during the process design and will be continued during the detailed design. The equipment number goes in the column labeled "Equipment No." on the equipment list.

Equipment Number: - T - 21 01 A

- A: Duplicate or installed spare
- 01: Sequence number
- 21: Area number - i.e., 21 (See area number description in Section 10.0 - Drawing List)
- T: Equipment letter (see below)

Equipment Letters	Equipment Category
B	Blowers
C	Columns (Carbon Units)
P	Pumps
T	Tanks
Z	Miscellaneous process equipment (Demisters and Diffusers)

3.2 EQUIPMENT LIST

Table 3-1 presents the equipment list for this process design.

TABLE 3-1

EQUIPMENT NUMBER	EQUIPMENT NAME	QUANTITY	EQUIPMENT DESCRIPTION	CAPACITY	UNITS	PFD NUMBER	PID NUMBER
** EQUIPMENT DESIGNATION : B							
* AREA NUMBER : 20							
B-2001 A-C	PRIMARY AERATION BLOWER	3	500 CFM, 4 PSIG, LOW PRESSURE ROTARY BLOWER, 20 HORSEPOWER (HP)	500	CFM	20-F01	20-D02
B-2002 A-C	SECONDARY AERATION BLOWER	3	500 CFM, 4 PSIG, LOW PRESSURE ROTARY BLOWER, 20 HP	500	CFM	20-F01	20-D03
B-2003 A,B	EXHAUST BLOWER	2	1000 CFM 4.0 PSIG, LOW PRESSURE ROTARY BLOWER, 25 HP, VARIABLE FREQUENCY DRIVE	1000	CFM	20-F01	20-D05

TABLE 3-1 (CONTINUED)

EQUIPMENT NUMBER	EQUIPMENT NAME	QUANTITY	EQUIPMENT DESCRIPTION	CAPACITY	UNITS	PFD NUMBER	PID NUMBER
** EQUIPMENT DESIGNATION : C							
* AREA NUMBER : 20							
C-2001 A,B	VAPOR-PHASE CARBON ADSORBER	2	S.S. VESSEL, SKID MOUNTED, 8" INLET & OUTLET FLANGED CONNECTIONS	1,800	LBS	20-F01	20-D05

TABLE 3-1 (CONTINUED)

EQUIPMENT NUMBER	EQUIPMENT NAME	QUANTITY	EQUIPMENT DESCRIPTION	CAPACITY	UNITS	PFD NUMBER	PID NUMBER
** EQUIPMENT DESIGNATION : P							
* AREA NUMBER : 20							
P-2001	EXTRACTION WELL PUMP #1	1	VERTICAL TURBINE PUMP - SS SHAFT WITH SS IMPELLER AND RUBBER BEARINGS, 30 HP, 100 FT TOTAL DYNAMIC HEAD (TDH)	400-600	GPM	20-F01	20-D01
P-2002	SECONDARY CONTAINMENT SUMP PUMP	1	SUBMERSIBLE PUMP - 3/4 HP, 14 FT TDH	50	GPM	20-F01	20-D01
P-2003 A,B	TREATED WATER DISCHARGE PUMP	2	VERTICAL TURBINE PUMP - SS SHAFT WITH SS IMPELLER AND RUBBER BEARINGS, 20 HP, 70 FT TDH	800	GPM	20-F01	20-D04
P-2004	EXTRACTION WELL PUMP #2	1	VERTICAL TURBINE PUMP - SS SHAFT WITH SS IMPELLER AND RUBBER BEARINGS, 15 HP, 100 FT TDH	200-400	GPM	20-F01	20-D01
P-2005	EXTRACTION WELL PUMP #3	1	VERTICAL TURBINE PUMP - SS SHAFT WITH SS IMPELLER AND RUBBER BEARINGS, 15 HP 100 FT TDH	200-400	GPM	20-F01	20-D01

TABLE 3-1 (CONTINUED)

EQUIPMENT NUMBER	EQUIPMENT NAME	QUANTITY	EQUIPMENT DESCRIPTION	CAPACITY	UNITS	PFD NUMBER	PID NUMBER
** EQUIPMENT DESIGNATION : T							
* AREA NUMBER : 20							
T-2001	PRIMARY AERATION TANK	1	8' x 40' x 8 1/2' RECTANGULAR TANK DIVIDED INTO 3 CHAMBERS, EPOXY LINED CARBON STEEL, VAPOR TIGHT	20,000	GAL	20-F01	20-D02
T-2002	SECONDARY AERATION TANK	1	8' x 40' x 8 1/2' RECTANGULAR TANK DIVIDED INTO 3 CHAMBERS, EPOXY LINED CARBON STEEL, VAPOR TIGHT	20,000	GAL	20-F01	20-D03
T-2003	DEGAS TANK	1	STANDARD CYLINDRICAL VERTICAL TANK, EPOXY LINED CARBON STEEL, VAPOR TIGHT, FLAT BOTTOM AND TOP	4,000	GAL	20-F01	20-D04

TABLE 3-1 (CONTINUED)

EQUIPMENT NUMBER	EQUIPMENT NAME	QUANTITY	EQUIPMENT DESCRIPTION	CAPACITY	UNITS	PFD NUMBER	PID NUMBER
** EQUIPMENT DESIGNATION : Z							
* AREA NUMBER : 20							
Z-2001 A-C	PRIMARY DIFFUSER	3	65 1' DIA FINE BUBBLE DIFFUSERS AND PIPING MANIFOLD TO FIT IN AERATION CHAMBER OF T-2001	500	CFM	20-F01	20-D02
Z-2002 A-C	SECONDARY DIFFUSER	3	65 1' DIA FINE BUBBLE DIFFUSERS AND PIPING MANIFOLD TO FIT IN AERATION CHAMBER OF T-2002	500	CFM	20-F01	20-D03
Z-2003 A,B	PRIMARY DEMISTER	2	VERTICAL IN-LINE IMPINGEMENT VANE W/ SS BLADES AND HOUSING 10" DIA BY 12" THICK	500	CFM	20-F01	20-D02
Z-2004 A,B	SECONDARY DEMISTER	2	VERTICAL IN-LINE IMPINGEMENT VANE W/ SS BLADES AND HOUSING 10" DIA BY 12" THICK	500	CFM	20-F01	20-D03

4.0 PROCESS EQUIPMENT SPECIFICATIONS

4.1 INTRODUCTION

Equipment specifications are a summary of the process calculations for a specific piece of equipment or for the several pieces of equipment constituting a process package or subsystem. Equipment specifications include performance requirements such as flow rate, discharge pressure, and volume. They may also include mechanical requirements such as materials of construction, size of openings, or type of motor. The basic performance and operating requirements are documented on the PFD and the material and energy balance.

Equipment specifications generally serve as a guide for the preparation of detail design, drawings, requisitions, or specifications. This procedure is based on the normal process of conducting an engineering, procurement, and construction project. In certain cases, the equipment specification may be the only document prepared to define the intent and/or content of a project.

4.2 SPECIFICATIONS

In accordance with normal procedure, certain information has not been completed on the specification sheets. This information will be completed during the detailed design.

COMPANY NAME: Wright-Patterson Air Force Base	PROJECT NO: 199814
PROJECT NAME: Ground Water Treatment System	CHARGE NO: 199814.05.03.01
LOCATION: WPAFB, Ohio	

TYPE: Rotary

NUMBER OF UNITS: 3

SERVICE CONDITIONS

Vapor or Gas Handled: Ambient Air
Specific Gravity: 1.0
Discharge Volumetric Flow @ P & T (acfm): 500 acfm
Air Inlet Temperature (° F): 100° F (maximum)
Air Discharge Pressure (psig): 4.0 psig
Relative Humidity: 0% - 100%

SPECIAL ACCESSORIES

- Noise Protection Housing - < 85 db A[1]
- Inlet and Discharge Silencer

DRIVER

Motor: Electric
Volts-Phase-Cycle: 480V/3-phase/60Hz
HP: 20 HP *
Enclosure: Totally Enclosed Fan Cooled (TEFC)

[1]85 decibles @ an A-weighted scale as specified under OSHA.

	EQUIPMENT NAME	EQUIPMENT NO.
	Primary Aeration Blower	B-2001 A-C
BY: J. Becker	MISCELLANEOUS EQUIPMENT SPECIFICATION	AREA NO. 20
CHECKED: RWH		AREA NAME
APP'D: D.H. Fuerst	REVISION 2/22/91 |A| 3/20/91 |B| |C|	Ground Water Treatment System
DATE: 3/20/91	VENDOR TO COMPLETE OR CONFIRM INFORMATION MARKED *	SHEET 2 OF 17

COMPANY NAME: Wright-Patterson Air Force Base	PROJECT NO: 199814
PROJECT NAME: Ground Water Treatment System	CHARGE NO: 199814.05.03.01
LOCATION: WPAFB, Ohio	

TYPE: Rotary

NUMBER OF UNITS: 3

SERVICE CONDITIONS

Vapor or Gas Handled: Ambient Air
Specific Gravity: 1.0
Discharge Volumetric Flow @ P & T (acfm): 500 acfm
Air Inlet Temperature (° F): 100° F (maximum)
Air Discharge Pressure (psig): 4.0 psig
Relative Humidity: 0% - 100%

SPECIAL ACCESSORIES

- Noise Protection Housing - < 85 db A[1]
- Inlet & Discharge Silencer

DRIVER

Motor: Electric
Volts-Phase-Cycle: 480V/3-phase/60Hz
HP: 20 HP *
Enclosure: Totally Enclosed Fan Cooled (TEFC)

[1]85 decibles @ an A-weighted scale as specified under OSHA.

	EQUIPMENT NAME	EQUIPMENT NO.
	Secondary Aeration Blower	B-2002 A-C
BY: J. Becker	MISCELLANEOUS EQUIPMENT SPECIFICATION	AREA NO. 20
CHECKED: RWH		AREA NAME
APP'D: DH Engel	REVISION 2/22/91 |A| 3/20/91 |B| |C|	Ground Water Treatment System
DATE: 3/20/91	VENDOR TO COMPLETE OR CONFIRM INFORMATION MARKED *	SHEET 3 OF 17

COMPANY NAME: Wright-Patterson Air Force Base	PROJECT NO: 199814
PROJECT NAME: Ground Water Treatment System	CHARGE NO: 199814.05.03.01
LOCATION: WPAFB, Ohio	

TYPE: Rotary - Positive Displacement

NUMBER OF UNITS: 2

SERVICE CONDITIONS

Vapor or Gas Handled: Air Saturated with H_2O and < 4 ppm of Trichloroethylene
Specific Gravity: 1.0
Discharge Volumetric Flow @ P & T (acfm): 600 - 1000 acfm
Air Inlet Temperature (°F): 55° F - 65° F
Suction: 0.5 psig
Discharge: 3.5 psig
Relative Humidity: 0 - 100%

SPECIAL ACCESSORIES

- Noise Protection Housing - < 85 db A[1]
- Inlet & Discharge Silencer

DRIVER

Motor: Electric - V Belt With Variable Frequency Drive
Volts-Phase-Cycle: 460V/3-phase/60Hz
HP: 25 HP *
Enclosure: Totally Enclosed Fan Cooled (TEFC)

[1] 85 decibles @ an A-weighted scale as specified under OSHA.

	EQUIPMENT NAME	EQUIPMENT NO.
	Exhaust Blower	B-2003 A,B
BY: J. Becker	MISCELLANEOUS EQUIPMENT SPECIFICATION	AREA NO. 20
CHECKED: RLW		AREA NAME
APP'D: D.H. Fink	REVISION 2/22/91 |A| 3/20/91 |B| |C|	Ground Water Treatment System
DATE: 3/20/91	VENDOR TO COMPLETE OR CONFIRM INFORMATION MARKED *	SHEET 4 OF 17

COMPANY NAME: Wright-Patterson Air Force Base	PROJECT NO: 199814
PROJECT NAME: Ground Water Treatment System	CHARGE NO: 199814.05.03.01
LOCATION: Dayton, Ohio	

TYPE: S.S. Skid Mounted Vapor Phase Carbon Unit 5

NUMBER OF UNITS: 2

SERVICE CONDITIONS

Volume Air Flow Rate: 600 - 1000 CFM
Carbon Volume: 60 cu ft
Vessel and Carbon Weight: 2840 lbs (fresh carbon); 4640 lbs (spent carbon)
Pressure Drop: 30 in H_2O (Maximum)
Operating Temperature: 60°F
Static Pressure Rating: 15 psig (Maximum)
Flow Direction: Down
Hose Connections: 8" 150lb. Flange (Top & Bottom)
Drain: 3/4" MNPT
Carbon Sample Port Near Inlet

MATERIALS OF CONSTRUCTION

Vessel: 316L Stainless Steel
Frame: Carbon Steel With Corrosion Protective Coating & Lifting Lugs
Flanges, Elbows, and Sample Fitting: 316L Stainless Steel

REPLACEMENT CONDITIONS

- Minimize Carbon Handling & Maintenance
- Regenerate Spent Carbon Off-Site

WRIGHT-PATTERSON AIR FORCE BASE — PROJECT NO. 199819

PROJECT NAME: GROUND WATER TREATMENT SYSTEM — CHARGE NO. 199819.05.03.01

LOCATION: WPAFB, OH

1	SERVICE CONDITIONS	Liquid Pumped	GROUND WATER		Max. Capacity at P.T.		600	gpm
2		Pumping Temperature (P.T.)	55 °F		Discharge Pressure	56.5 psig	130	ft.
3		Specific Gravity at P.T.	1.0		Suction Pressure	0 psig	0	ft.
4		Viscosity at P.T.	1.13 (cp) cp		Differential Pressure	56.5 psi		
5		Vapor Pressure at P.T.	0.28 lb/in²		Differential Head	130 ft		ft.
6		Corrosion or Erosion Factors:	MINERAL, ORGANIC		NPSH Available	33 ft		ft.
7			& DIRT PARTICLES		NPSH Required (Water)	*		ft.
8	CONSTRUCTION DETAILS	Arrangement: Horiz. (Vert.) In Line			Suction: (Single) - Double			
9		Direction of Rotation Facing Pump Coupling: CW - CCW *			Speed:	1770		rpm
10		Case: Design Pressure	* psig		Number of Stages	*	Shut-Off Pressure *	ft.
11		Max. Allow. Working Press.	* psig		Volumetric Efficiency at Rating			%
12		Split: Horiz.-Vert.-Barrel			Impeller Type	*		
13		Impeller Diameter: Supplied	* inches; *		Maximum	* inches; Minimum	*	inches
14		Vent and Drain Tapped: Yes - No			Bearings: Thrust	* Type	*	
15		Nozzles: Size / Rating / Facing / Location			Radial	* Type	*	
16		Suction	PROVIDE STRAINER	BOTTOM	Lubrication on Bearings: Oil - (Grease) *			
17		Discharge	* 150 lb.	RF TOP	Oiler: Yes - (No); Type	*		
18		Vents			Coupling: (Yes) - No; Mfr.	*		
19		Drains	Weep Hole in Casing		Coupling Guard: (Yes) - No	*		
20		Cooling H2O			Baseplate: (Yes) - No; Type	*		
21		Water Cooling: Casing-Stuff. Box-Bearings-Pedestal-Gland-None			Total Water Required:	*		gpm
22		Smothering Gland: Yes - No	*		Lubrication on Stuffing Box: Oil-Grease-None			
23		Packing: Yes - No; Type	*		Sealing Oil Connection: Yes - No			
24		Mechanical Seal: Yes - (No) Furnished by:			; Mfr.	Type		
25		Single - Double-Inside-Outside-Balanced-Unbalanced						
26		Rotary Unit ; Seal Ring			; Face Material	; Shaft Packing		
27		Insert ; Reversible: Yes - No			; Face Material			
28		Insert Mounting: Clamped In - "O" Ring - Press Fit						
29		Gland ; Plain: Yes - No			Throttle Bushing Carbon: Yes - No ; Other			
30		Gland/Stuffing Box Machined & Tapped for: Dead - End Lub. - Circulating Lub. - Quenching - Vent & Drain						
31		Flushing Seal Faces with Discharge Bypass - Flushing Seal Faces with External Fluid						
32		Auxiliary Stuffing Box Req'd: Yes - No						
33		Weight of Pump	*		lb; Weight of Base	*		lb
34		Weight of Driver	*		lb; Shipping Weight	*		lb
35	MATERIALS	Casing & Covers:	S.S.		Shaft:	S.S.		
36		Casing Wear Rings:	*		Shaft Sleeves:	*		
37		Impeller:	S.S.		Lantern Rings:	*		
38		Impeller Wear Rings:	*		Glands:	*		
39		Stuffing Box Bushings:	*		Gaskets:	*		
40	DRIVER	Furnished by:	* ; Type (Elec.) Motor - Steam Turbine - Other		*	; (Direct) - Gear - Belt - V Rope *		
41		Electric Motor: Make	* Mounted by *		Steam Turbine: Make		Mounted by	
42		Enclosure * SF * Temp Rise * °C			Model:			
43		Insulation * Frame *			Horsepower	hp, Speed		rpm
44		Estimated BHP Req'd. *	hp		Inlet Steam Press., psig: Normal	, Max		
45		Nominal Motor Size (Non-overloading)	30 * hp		Inlet Steam Temp., °F. Normal	, Max.		
46		Speed *	rpm		Water Rate:			lb/hr
47		Volts 480 , Phase 3Ø ; Cycle 60HZ			Vacuum (If any)			mm - in. Hg - psig
48		Speed Reducer: Integral - Separate *			Back Pressure			psig
49		Mfr. * Ratio *			Nozzles	Size	Rating	Facing / Location
50		Model * Class *			Inlet			
51		See Driver Specification No. *			Exhaust			
52	TESTS	Performance Curve: Yes - No; Curve No. *		MISC.	Serial Number *			
53		Certified: Yes - No *			Outline Drawing *			
54		Hydrostatic Test: Yes - No; Pressure *	psig		Cross Section Drawing *			
55		Shop Inspection: Yes - No *						

CORPORATION	EQUIPMENT NAME: EXTRACTION WELL PUMP	EQUIPMENT NO.: P-2001
BY: J. BECKER	CENTRIFUGAL PUMP SPECIFICATION	AREA NO. 20
CHECKED:		AREA NAME GROUND WATER TREATMENT SYSTEM
APP'D:	REVISION A 2/22/91 B 3/20/91 C	
DATE: 2/21/91	VENDOR TO COMPLETE INFORMATION MARKED *	SHEET 6 OF 17

WRIGHT-PATTERSON AIR FORCE BASE | PROJECT NO. 199814

PROJECT NAME GROUND WATER TREATMENT SYSTEM | CHARGE NO. 199817.050301

LOCATION: WPAFB, OH

1	SERVICE CONDITIONS	Liquid Pumped RUNOFF FROM [illegible]		Max. Capacity at P.T.		50	gpm
2		Pumping Temperature (P.T.)	32 - 75 °F	Discharge Pressure	7 psig	16.1	ft.
3		Specific Gravity at P.T.		Suction Pressure	0 psig	0	ft.
4		Viscosity at P.T.	1.13 (ED) cs	Differential Pressure	7 psig		
5		Vapor Pressure at P.T.	0.28 lb/in²	Differential Head	16.1 ft.		ft.
6		Corrosion or Erosion Factors:	SILT, LEAVES	NPSH Available	33 ft		ft.
7				NPSH Required (Water)	*		ft.
8	CONSTRUCTION DETAILS	Arrangement: Horiz.-Vert.-In Line	SUMP TYPE	Suction: (Single) Double			
9		Direction of Rotation Facing Pump Coupling: CW - CCW		Speed:	1750		rpm
10		Case: Design Pressure	* psig	Number of Stages	; Shut-Off Pressure *		ft.
11		Max. Allow. Working Press.	* psig	Volumetric Efficiency at Rating	*		%
12		Split: Horiz.-Vert.-Barrel		Impeller Type	OPEN		
13		Impeller Diameter: Supplied *	inches; *	Maximum *	inches; Minimum *		inches
14		Vent and Drain Tapped: Yes - No *		Bearings: Thrust *	Type *		
15		Nozzles: Size / Rating / Facing / Location		Radial *	Type *		
16		Suction	PROVIDE STRAINER	Lubrication on Bearings: Oil - (Grease)			
17		Discharge *	RF TYP.	Oiler: Yes - (No) Type	*		
18		Vents		Coupling: (Yes) - No; Mfr.	*		
19		Drains		Coupling Guard: (Yes) - No	*		
20		Cooling H2O		Baseplate: (Yes) - No; Type	STEEL COVER		
21		Water Cooling: Cas.ng-Stuff. Box-Bearings-Pedestal-Gland-(None)		Total Water Required:	*		gpm
22		Smothering Gland: Yes - (No)		Lubrication on Stuffing Box: Oil-Grease-(None)			
23		Packing: Yes - (No) Type		Sealing Oil Connection: Yes - No			
24		Mechanical Seal: Yes - No; Furnished by:		; Mfr.	Type		
25		(Single) - Double-Inside-Outside-Balanced-Unbalanced					
26		Rotary Unit ; Seal Ring		; Face Material	; Shaft Packing		
27		Insert ; Reversible: Yes - No		; Face Material			
28		Insert Mounting: Clamped in - "O" Ring - Press Fit					
29		Gland ; Plain: Yes - No		Throttle Bushing Carbon: Yes - No ; Other			
30		Gland/Stuffing Box Machined & Tapped for: Dead - End Lub. - Circulating Lub. - Quenching - Vent & Drain					
31		Flushing Seal Faces with Discharge Bypass - Flushing Seal Faces with External Fluid					
32		Auxiliary Stuffing Box Req'd: Yes - (No)					
33		Weight of Pump *	lb; Weight of Base *				lb
34		Weight of Driver *	lb; Shipping Weight *				lb
35	MATERIALS	Casing & Covers:	ALL IRON	Shaft:	*		
36		Casing Wear Rings:	*	Shaft Sleeves:	STEEL		
37		Impeller:	ALL IRON	Lantern Rings:	*		
38		Impeller Wear Rings:	*	Glands:	*		
39		Stuffing Box Bushings:	*	Gaskets:	*		
40	DRIVER	Furnished by: *	; Type (Elec) Motor - Steam Turbine - Other *	(Direct) Gear - Belt - V Rope			
41		Electric Motor: Make *	Mounted by	Steam Turbine: Make	Mounted by		
42		Enclosure * SF	Temp Rise °C	Model:			
43		Insulation *	Frame	Horsepower	hp, Speed		rpm
44		Estimated BHP Req'd. *	hp	Inlet Steam Press., psig: Normal	; Max		
45		Nominal Motor Size (Non-overloading) 3/4 *	hp	Inlet Steam Temp., °F. Normal	; Max.		
46		Speed 1750	rpm	Water Rate:			lb/hr
47		Volts 480 Phase 30 ; Cycle 60 HZ		Vacuum (if any)			mm - in. Hg - psia
48		Speed Reducer: Integral - Separate		Back Pressure			psig
49		Mfr. Ratio		Nozzles	Size / Rating / Facing / Location		
50		Model Class		Inlet			
51		See Driver Specification No.		Exhaust			
52	TESTS	Performance Curve: (Yes) - No: Curve No.		MISC. Serial Number *			
53		Certified: Yes - (No)		Outline Drawing *			
54		Hydrostatic Test: Yes - (No); Pressure	psig	Cross Section Drawing *			
55		Shop Inspection: Yes - (No)					

YEC CORPORATION

BY: J. BECKER

CHECKED: [illegible]

APP'D: [illegible]

DATE 2/21/91

EQUIPMENT NAME: SECONDARY CONTAINMENT SUMP POND

EQUIPMENT NO. P-2002

CENTRIFUGAL PUMP SPECIFICATION

AREA NO. 20

AREA NAME GROUND WATER TREATMENT SYSTEM

REVISION | A | 2/22/91 | B | 5/20/91 | C |

VENDOR TO COMPLETE INFORMATION MARKED *

SHEET 7 OF 17

CUSTOMER NAME	WRIGHT-PATTERSON AIR FORCE BASE	PROJECT NO.	199819
PROJECT NAME	GROUND WATER TREATMENT SYS	CHARGE NO.	199819.05.03.01
LOCATION	WPAFB, OH		VERTICAL TURBINE PUMP

SERVICE CONDITIONS	Liquid Pumped	GROUND WATER		Max. Capacity at P.T.		800	gpm
	Pumping Temperature (P.T.)	55 °F		Discharge Pressure	31 psig	70	ft.
	Specific Gravity at P.T.	1.0		Suction Pressure	0 psig	0	ft.
	Viscosity at P.T.	1.13 (SS) cp		Differential Pressure	31 psig		
	Vapor Pressure at P.T.	0.281 lb/in²		Differential Head	70 ft		ft.
	Corrosion or Erosion Factors:	Fine iron particulate		NPSH Available	33 ft		ft.
				NPSH Required (Water)	*		ft.

CONSTRUCTION DETAILS	Arrangement: Horiz. (Vert.)-In Line			Suction: (Single)- Double			
	Direction of Rotation Facing Pump Coupling: CW - CCW			Speed:	1770		rpm
	Case: Design Pressure	* psig		Number of Stages	; Shut-Off Pressure	*	ft.
	Max. Allow. Working Press.	* psig		Volumetric Efficiency at Rating		*	%
	Split: Horiz.-Vert.-Barrel			Impeller Type		CLOSE	
	Impeller Diameter: Supplied	* inches; *		Maximum	* inches; Minimum	*	inches
	Vent and Drain Tapped: (Yes) - No			Bearings: Thrust	Type		

Nozzles	Size	Rating	Facing	Location
Suction	PROVIDE	STRAINER	BELL TYPE	BOTTOM
Discharge	*	150	R.F.	TOP
Vents				
Drains	WEEP HOLE IN CASING			
Cooling H2O				

Radial	Type *
Lubrication on Bearings: Oil - (Grease)	*
Oiler: Yes - (No) Type	*
Coupling: (Yes) - No; Mfr.	Flanged, Adjustable
Coupling Guard: (Yes) - No	*
Baseplate: (Yes) - No; Type	Round, ANSI FF 150lb.
Water Cooling: Casing-Stuff. Box-Bearings-Pedestal-Gland-None	Total Water Required: gpm
Smothering Gland: Yes - No *	Lubrication on Stuffing Box: Oil-Grease-None
Packing: Yes - No; Type *	Sealing Oil Connection: Yes - (No)
Mechanical Seal: Yes (No) Furnished by:	; Mfr. Type
(Single) - Double-Inside-Outside-Balanced-Unbalanced	
Rotary Unit ; Seal Ring	; Face Material ; Shaft Packing
Insert ; Reversible: Yes - No	; Face Material
Insert Mounting: Clamped In - "O" Ring - Press Fit	
Gland ; Plain: Yes - No	Throttle Bushing Carbon: Yes - No ; Other
Gland/Stuffing Box Machined & Tapped for: Dead - End Lub. - Circulating Lub. - Quenching - Vent & Drain	
Flushing Seal Faces with Discharge Bypass - Flushing Seal Faces with External Fluid	
Auxiliary Stuffing Box Req'd: Yes - No	
Weight of Pump * lb; Weight of Base	* lb
Weight of Driver * lb; Shipping Weight	* lb

MATERIALS		
Casing & Covers:	CAST IRON	Shaft: SS
Casing Wear Rings:	*	Shaft Sleeves: *
Impeller:	SS	Lantern Rings: *
Impeller Wear Rings:	*	Glands: *
Stuffing Box Bushings:	*	Gaskets: *

DRIVER		
Furnished by: *	; Type (Elec) Motor - Steam Turbine - Other	* ; (Direct) Gear - Belt - V Reas
Electric Motor: Make *	Mounted by	Steam Turbine: Make Mounted by
Enclosure * SF *	Temp Rise * °C	Model:
Insulation *	Frame *	Horsepower hp, Speed rpm
Estimated BHP Req'd. *	hp	Inlet Steam Press., psig: Normal ; Max
Nominal Motor Size (Non-overloading) 20 *	hp	Inlet Steam Temp., °F: Normal ; Max.
Speed 1750	rpm	Water Rate: lb/hr
Volts 480 V. Phase 3Ø ; Cycle 60HZ		Vacuum (if any) mm - in. Hg - psia
Speed Reducer: Integral - Separate *		Back Pressure psig
Mfr. * Ratio *		
Model * Class *		
See Driver Specification No. *		

Nozzles	Size	Rating	Facing	Location
Inlet				
Exhaust				

TESTS		MISC.	
Performance Curve: Yes - No; Curve No. *		Serial Number *	
Certified: Yes - No *		Outline Drawing *	
Hydrostatic Test: Yes - No; Pressure *	psig	Cross Section Drawing *	
Shop Inspection: Yes - No *			

CORPORATION	EQUIPMENT NAME	TREATED WATER DISCHARGE PUMP	EQUIPMENT NO. P-2003 A,B
BY: J. Becker	CENTRIFUGAL PUMP SPECIFICATION		AREA NO. 20
CHECKED: [illegible]			AREA NAME GROUND WATER TREATMENT SYSTEM
APP'D: J. Wilhelm	REVISION A 2/22/91 B 3/20/91 C		
DATE: 2/21/91	VENDOR TO COMPLETE, INFORMATION MARKED *		SHEET 8 OF 17

SI CONTROL

COMPANY NAME WRIGHT-PATTERSON AIR FORCE BASE	PROJECT NO. 199814
PROJECT NAME GROUNDWATER TREATMENT SYSTEM	CHARGE NO. 199814.05.03.01
LOCATION WPAFB	

1	SERVICE CONDITIONS	Liquid Pumped: GROUND WATER			Max. Capacity at P.T.	400	gpm
2		Pumping Temperature (P.T.)	55	°F	Discharge Pressure: 49.8 psig	103	ft.
3		Specific Gravity at P.T.	1.0		Suction Pressure: 0 psig	0	ft.
4		Viscosity at P.T.	1.13	(cs) cp	Differential Pressure: 49.8 psi		
5		Vapor Pressure at P.T.	0.28	lb/in²	Differential Head: 103 FT		ft.
6		Corrosion or Erosion Factors: MINERAL ORGANIC			NPSH Available: 33 ft		ft.
7		AND DIRT PARTICLES			NPSH Required (Water): *		ft.
8	CONSTRUCTION DETAILS	Arrangement: Horiz. (Vert.) In Line			Suction: (Single) Double		
9		Direction of Rotation Facing Pump Coupling: CW - CCW *			Speed: 1770		rpm
10		Case: Design Pressure *		psig *	Number of Stages *	Shut-Off Pressure *	ft.
11		Max. Allow. Working Press. *		psig *	Volumetric Efficiency at Rating		%
12		Split: Horiz.-Vert.-Barrel *			Impeller Type *		
13		Impeller Diameter: Supplied *		inches;	Maximum *	inches; Minimum *	inches
14		Vent and Drain Tapped: Yes - No *			Bearings: Thrust *	Type *	
15		Nozzles: Size / Rating / Facing / Location			Radial *	Type *	
16		Suction: PROVIDE STRAINER		BOTTOM	Lubrication on Bearings; Oil (Grease) *		
17		Discharge: *	150lb	RT TOP	Oiler: Yes (No) Type		
18		Vents			Coupling: (Yes) - No; Mfr. *		
19		Drains: WEEP HOLE IN CASING			Coupling Guard (Yes) - No *		
20		Cooling H2O			Baseplate: (Yes) - No; Type *		
21		Water Cooling: Casing-Stuff. Box-Bearings-Pedestal-Gland-None			Total Water Required: *		gpm
22		Smothering Gland: Yes - No *			Lubrication on Stuffing Box: Oil-Grease-None *		
23		Packing: Yes - No; Type *			Sealing Oil Connection: Yes - No *		
24		Mechanical Seal: Yes - (No); Furnished by:			; Mfr.	Type	
25		Single - Double-Inside-Outside-Balanced-Unbalanced					
26		Rotary Unit ; Seal Ring			; Face Material	; Shaft Packing	
27		Insert ; Reversible: Yes - No			; Face Material		
28		Insert Mounting: Clamped In - "O" Ring - Press Fit					
29		Gland ; Plain: Yes - No			Throttle Bushing Carbon: Yes - No ; Other		
30		Gland/Stuffing Box Machined & Tapped for: Dead - End Lub. - Circulating Lub. - Quenching - Vent & Drain					
31		Flushing Seal Faces with Discharge Bypass - Flushing Seal Faces with External Fluid					
32		Auxiliary Stuffing Box Req'd: Yes - No					
33		Weight of Pump *		lb;	Weight of Base *		lb
34		Weight of Driver *		lb;	Shipping Weight *		lb
35	MATERIALS	Casing & Covers: S.S.			Shaft: S.S.		
36		Casing Wear Rings: *			Shaft Sleeves: *		
37		Impeller: S.S.			Lantern Rings: *		
38		Impeller Wear Rings: *			Glands: *		
39		Stuffing Box Bushings: *			Gaskets: *		
40	DRIVER	Furnished by: * ; Type (Elec. Motor - Steam Turbine - Other *			; (Direct) Gear - Belt - V Rope *		
41		Electric Motor: Make *	Mounted by *		Steam Turbine: Make	Mounted by	
42		Enclosure SF	Temp Rise °C		Model:		
43		Insulation Frame *			Horsepower hp ; Speed		rpm
44		Estimated BHP Req'd. *		hp	Inlet Steam Press., psig: Normal	; Max	
45		Nominal Motor Size (Non-overloading) 30 *		hp	Inlet Steam Temp., °F: Normal	; Max.	
46		Speed *		rpm	Water Rate:		lb/hr
47		Volts 480 , Phase 3Ø ; Cycle 60 Hz			Vacuum (If any)		mm - in. Hg - psia
48		Speed Reducer: Integral - Separate *			Back Pressure		psig
49		Mfr. * Ratio *			Nozzles: Size / Rating / Facing / Location		
50		Model * Class *			Inlet		
51		See Driver Specification No. *			Exhaust		
52	TESTS	Performance Curve: Yes - No; Curve No. *			MISC. Serial Number *		
53		Certified: Yes - No *			Outline Drawing *		
54		Hydrostatic Test: Yes - No; Pressure *		psig	Cross Section Drawing *		
55		Shop Inspection: Yes - No *					

TT CORPORATION	EQUIPMENT NAME: EXTRACTION WELL PUMP	EQUIPMENT NO.: P-2004
BY: J Booker	CENTRIFUGAL PUMP SPECIFICATION	AREA NO.: 20
CHECKED: RWH		AREA NAME: GROUNDWATER TREATMENT
APP'D	REVISION: A 2/22/91 B 3/5/91 C	
DATE	VENDOR TO COMPLETE INFORMATION MARKED *	SHEET 9 OF 17

COMPANY NAME	WRIGHT-PATTERSON AIR FORCE BASE	PROJECT NO.	199819
PROJECT NAME	GROUND WATER TREATMENT SYSTEM	CHARGE NO.	199819.05.03.01
LOCATION	WPAFB		

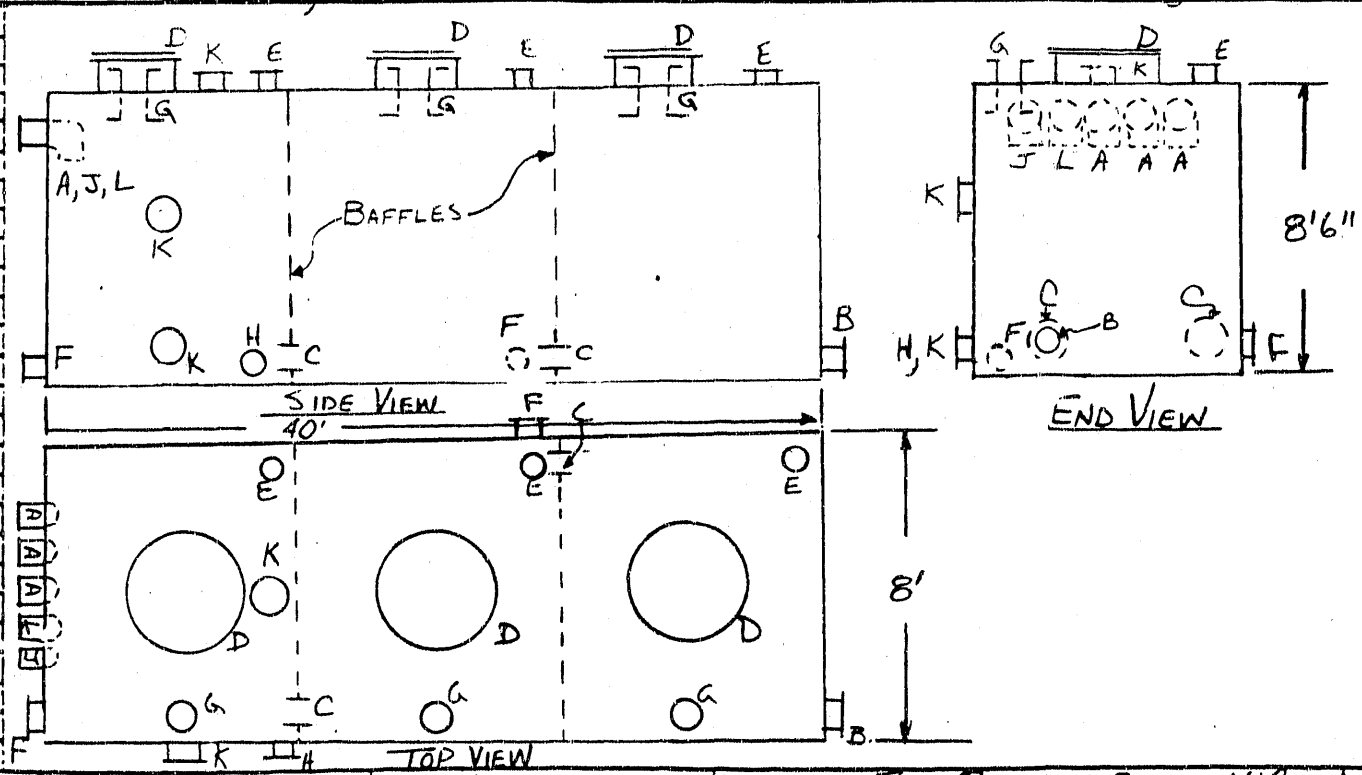
1	SERVICE CONDITIONS	Liquid Pumped	GROUND WATER		Max. Capacity at P.T.		400	gpm
2		Pumping Temperature (P.T.)	55 °F		Discharge Pressure	49.8 psig	103	ft.
3		Specific Gravity at P.T.	1.0		Suction Pressure	0 psig	0	ft.
4		Viscosity at P.T.	1.13 (cs)cp		Differential Pressure	49.8 psig		
5		Vapor Pressure at P.T.	0.2810 in ≈		Differential Head	103 Ft		ft.
6		Corrosion or Erosion Factors:	MINERAL, ORGANIC		NPSH Available	33 Ft.		ft.
7			& DIRT PARTICLES		NPSH Required (Water)	*		ft.
8	CONSTRUCTION DETAILS	Arrangement: Horiz (Vert)-In Line			Suction (Single)-Double			
9		Direction of Rotation Facing Pump Coupling: CW - CCW *			Speed:	1770		rpm
10		Case: Design Pressure *	psig *		Number of Stages *	;Shut-Off Pressure *		ft.
11		Max. Allow. Working Press. *	psig *		Volumetric Efficiency at Rating		*	%
12		Split: Horiz-Vert-Barrel *			Impeller Type *			
13		Impeller Diameter: Supplied *	inches;		Maximum *	inches; Minimum *		inches
14		Vent and Drain Tapped: Yes - No *			Bearings: Thrust *	Type *		
15		Nozzles / Size / Rating / Facing / Location			Radial *	Type *		
16		Suction	PROVIDE STRAINER	BOTTOM	Lubrication on Bearings; Oil - (Grease) *			
17		Discharge	* 150lb.	RF TOP	Oiler: Yes (No) Type	*		
18		Vents			Coupling: (Yes) - No; Mfr. *			
19		Drains	WEEP HOLE IN CASING		Coupling Guard: (Yes) - No *			
20		Cooling H2O			Baseplate (Yes) No; Type *			
21		Water Cooling: Casing-Stuff. Box-Bearings-Pedestal-Gland-None			Total Water Required: *			gpm
22		Smothering Gland: Yes - No *			Lubrication on Stuffing Box: Oil-Grease-None *			
23		Packing: Yes - No; Type *			Sealing Oil Connection: Yes - No			
24		Mechanical Seal: Yes - No; Furnished by:			; Mfr.	Type		
25		Single - Double-Inside-Outside-Balanced-Unbalanced						
26		Rotary Unit ; Seal Ring			; Face Material	; Shaft Packing		
27		Insert ; Reversible: Yes - No			; Face Material			
28		Insert Mounting: Clamped In - "O" Ring - Press Fit						
29		Gland ; Plain: Yes - No			Throttle Bushing Carbon: Yes - No ; Other			
30		Gland/Stuffing Box Machined & Tapped for: Dead - End Lub. - Circulating Lub. - Quenching - Vent & Drain						
31		Flushing Seal Faces with Discharge Bypass - Flushing Seal Faces with External Fluid						
32		Auxiliary Stuffing Box Req'd: Yes - No						
33		Weight of Pump *	lb;		Weight of Base *			lb
34		Weight of Driver *	lb;		Shipping Weight *			lb
35	MATERIALS	Casing & Covers:	S.S.		Shaft:	S.S.		
36		Casing Wear Rings:	*		Shaft Sleeves:	*		
37		Impeller:	S.S.		Lantern Rings:	*		
38		Impeller Wear Rings:	*		Glands:	*		
39		Stuffing Box Bushings:	*		Gaskets:	*		
40	DRIVER	Furnished by: * ; Type (Elec) Motor - Steam Turbine - Other			* (Direct) - Gear - Belt - V Rope *			
41		Electric Motor: Make *	Mounted by *		Steam Turbine: Make	Mounted by —		
42		Enclosure SF	Temp Rise °C		Model:			
43		Insulation	Frame *		Horsepower	hp ; Speed		rpm
44		Estimated BHP Req'd.	* hp		Inlet Steam Press., psig: Normal	; Max		
45		Nominal Motor Size (Non-overloading)	30 * hp		Inlet Steam Temp., °F: Normal	; Max.		
46		Speed	1 rpm		Water Rate:			lb/hr
47		Volts 480 ; Phase 3Ø ; Cycle 60HZ			Vacuum (if any)	—		mm - in. Hg - psia
48		Speed Reducer - Integral - Separate			Back Pressure			psig
49		Mfr. *	Ratio *		Nozzles / Size / Rating / Facing / Location			
50		Model *	Class *		Inlet			
51		See Driver Specification No. *			Exhaust			
52	TESTS	Performance Curve: Yes - No; Curve No. *			MISC. Serial Number *			
53		Certified: Yes - No *			Outline Drawing *			
54		Hydrostatic Test: Yes - No; Pressure *	psig		Cross Section Drawing *			
55		Shop Inspection: Yes - No *						

CORPORATION	EQUIPMENT NAME: EXTRACTION WELL PUMP		EQUIPMENT NO.: P-20C5
BY: J. BECKER	CENTRIFUGAL PUMP SPECIFICATION		AREA NO.: 20
CHECKED: [illegible]			AREA NAME: GROUND WATER TREATMENT SYSTEM
APP'D: [illegible]	REVISION: A 3/22/91 B 3/20/91 C		
DATE: 2/21/91	VENDOR TO COMPLETE INFORMATION MARKED *		SHEET 10 OF 17

OF CONTR.

PROJECT NO. 197014

PROJECT NAME: Ground Water Treatment System
CHARGE NO.: 199814.05.03.01
LOCATION: WPAFB, OH
20,000 gal



DESIGN DATA

Operating Pressure psig	ATM	
Operating Temperature °F	AMBIENT	
Liquid Specific Gravity	1.0	
Contents Lethal	Yes (No)	
Design Pressure ~~psig~~	15" H2O	
Design Temperature °F	140	
Max. All. Press. (New & Cold) psig		
~~Limited By~~: FLUID	GROUNDWATER W/TCE	
Hydrostatic Test psig	Fill With Water	
Shell / Heads Corr. Allow. in.	1/16"	1/16"
Shell / Heads Joint Eff. %	*	*
Code:	Stamp Req'd Yes No	
Radiograph:	Stress Relieve:	
National Board No.		

Type Supports: FLAT BOTTOM TO REST ON Concrete Pad
Insulation: yes
Fireproofing: No
Sandblast: yes — Paint: RED OXIDE PRIMER (OUTSIDE)
Manhole: Hinged Davited (Other) SEE BELOW
Platform Clips: Yes — Ladder Clips: Yes
Pipe Supports: Yes — Insul. Rings: Yes

Wt. Empty * lb — Wt. Full of Water * lb

MATERIALS

Item	Thickness	Mat'l Class	Mat'l-Minimum Quality
Shell	* in.		CARBON STEEL
Heads	* in.		CARBON STEEL
Lining	in.		EPOXY (INSIDE)
Baffles	* in.		CARBON Steel
	in.		
Nos. Necks			CARBON STEEL
Flanges			CARBON Steel
Coupling			Carbon Steel
M.M. Cover			Carbon Steel
Supports			Carbon Steel
Bolts Studs			Carbon Steel
Nuts			Carbon Steel
Gaskets			

NOZZLE SCHEDULE

Service	Mark	No.	Size	Rating	Face	Type
WATER INLET	A	3	6"	150lb	RF	Flg
WATER OUTLET	B	1	10"	150lb	RF	Flg
FLOW THROUGH	C	2	12"			
MANWAY	D	3	36"		FF	Flg w/Cover
VENT	E	3	12"	150lb	RF	Flg
DRAIN	F	2	4"	150lb	RF	Flg
AIR INLET	G	3	3"	150lb	RF	Drilled Flg
SAMPLE	H	1	1"	150lb	RF	Flg
SUMP INLET	J	1	2"	150lb	RF	Flg
Sight Glass	K	3	8"	150 lb	RF	Flg
RECYCLE	L	1	6"	150 lb	RF	Flg
	M					
	N					
	P					
	Q					
	R					
	S					
	T					

* Nozzle to be Plugged or Blinded

CORPORATION

EQUIPMENT NAME: Primary Aeration Tank
EQUIPMENT NO.: T-2001

BY: R.L. Anderson
CHECKED: [illegible]
APP'D: W.W. Heffick
DATE: 2/21/91

HORIZONTAL VESSEL SPECIFICATION

AREA NO.: 20
AREA NAME: Ground Water Treatment System

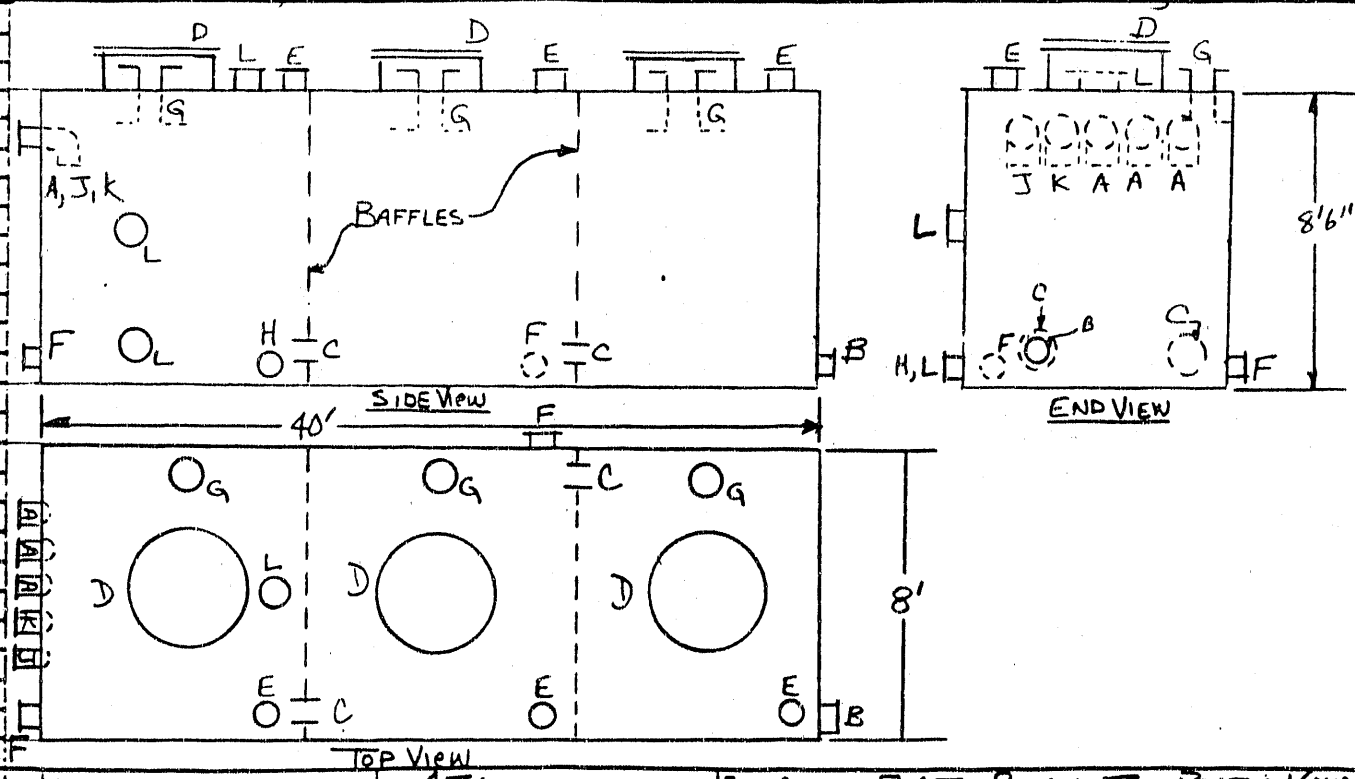
REVISION: A 2/22/91 | B 3/20/91 | 0 1/31/92

VENDOR TO COMPLETE INFORMATION MARKED * OR CONFIRM

SHEET 11 OF 17

PROJECT NAME GROUNDWATER TREATMENT SYSTEM | CHARGE NO. 199814.05.03.01

LOCATION WPAFB, OH | 20,000 gal



DESIGN DATA

Operating Pressure	psig	ATM		
Operating Temperature	°F	AMBIENT		
Liquid Specific Gravity		1.0		
Contents Lethal		Yes (No)		
Design Pressure	~~psig~~	15" H2O		
Design Temperature	°F	140		
Max. All. Press. (New & Cold)	psig			
~~Limited By~~		FLUID	Groundwater with TCE	
Hydrostatic Test	psig	Fill With Water		
Shell | Heads Corr. Allow.	in.	1/16"	1/16"	
Shell | Heads Joint Eff.	%	*	*	
Code:		Stamp Req'd Yes No		
Radiograph:		Stress Relieve:		
National Board No.				

Type Supports: FLAT BOTTOM TO REST ON CONCRETE PAD
Insulation: Yes
Fireproofing: No
Sandblast: Yes — Paint: RED Oxide Primer
Manhole | Hinged | Davited | (Other) SEE BELOW
Platform Clips: Yes — Ladder Clips: Yes
Pipe Supports: Yes — Insul. Rings: Yes
Wt. Empty * lb — Wt. Full of Water * lb

MATERIALS

Item	Thickness	Mat'l Class	Mat'l-Minimum Quality
Shell	* in.		Carbon Steel
Heads	* in.		Carbon Steel
Lining	* in.		EPOXY
Baffles	* in.		Carbon Steel
	in.		
Noz. Necks			Carbon Steel
Flanges			Carbon Steel
Coupling			Carbon Steel
M.H. Cover			Carbon Steel
Supports			Carbon Steel
Bolts Studs			Carbon Steel
Nuts			Carbon Steel
Gaskets			

NOZZLE SCHEDULE

Service	Mark	No.	Size	Rating	Face	Type
WATER INLET	A	3	6"	150 lb	RF	FLG
WATER OUTLET	B	1	10"	150 lb	RF	FLG
FLOWTHROUGH	C	2	12"			
MANWAY	D	3	36"		FF	FLG w/ Cover
VENT	E	3	12"	150 lb	RF	FLG
DRAIN	F	2	4"	150 lb	RF	FLG
AIR INLET	G	3	3"	150 lb	RF	Double Flg
SAMPLE	H	1	1"	150 lb	RF	FLG
RECYCLE	J	1	6"	150 lb	RF	FLG
SUMP INLET	K	1	2"	150 lb	RF	FLG
SIGHT GLASS	L	3	8"	150 lb	RF	FLG
	M					
	N					
	P					
	Q					
	R					
	S					
	T					

* Nozzle to be Plugged or Blinded

LT CORPORATION

EQUIPMENT NAME: Secondary Aeration Tank
EQUIPMENT NO.: T-2002

BY R.L. Anderson
CHECKED [illegible]
APP'D [illegible]
DATE 12/21/91

HORIZONTAL VESSEL SPECIFICATION

REVISION | A | 2/22/91 | B | 3/20/91 | 0 | 1/31/192

AREA NO 20
AREA NAME Groundwater Treatment

VENDOR TO COMPLETE INFORMATION MARKED * OR CONFIRM

SHEET 12 OF 17

COMPANY NAME: WRIGHT PATTERSON AIRFORCE BASE	PROJECT NO. 199814
PROJECT NAME: WRIGHT PATTERSON	CHARGE NO. 199814.05.03.01
LOCATION: DAYTON, OH	

FIELD ERECTED: YES (NO) | NO. UNITS: 1 | TOTAL VOLUME: 4000 GAL

DESIGN DATA

1	Operating Pressure psig	ATM	
2	Operating Temperature °F	AMBIENT	
3	Liquid Specific Gravity	1.0	
4	Contents Lethal	Yes (No)	
5	Design Pressure ~~psig~~	15" H_2O	
6	Design Temperature °F	140	
7	FLUID	GROUNDWATER WITH TCE	
8			
9	Hydrostatic Test psig	FILL WITH WATER	
10	Shell / Heads Corr. Allow. in.	1/16"	1/16"
11	Shell / Heads Joint Eff. %	*	*
12	Code: ASTM	Stamp Yes (No)	
13	Radiograph:	Stress Relieve:	
14	National Board No.		
15	Type Supports: Flat bottom to rest on concrete pad.		
16	Insulation: Yes		
17	Fireproofing: No		
18	Sandblast:	Paint RED OXIDE PRIMER (OUTSIDE)	
19	Manhole (Hinged) Davited Other		
20	Platform Clips: Yes / Ladder Clips: Yes / Insul. Rings: Yes		
21	Pipe Supports: Yes		
22	Wind Load: 70	Seismic: I	
23	Wt. Empty * lb	Wt Full of Water * lb	

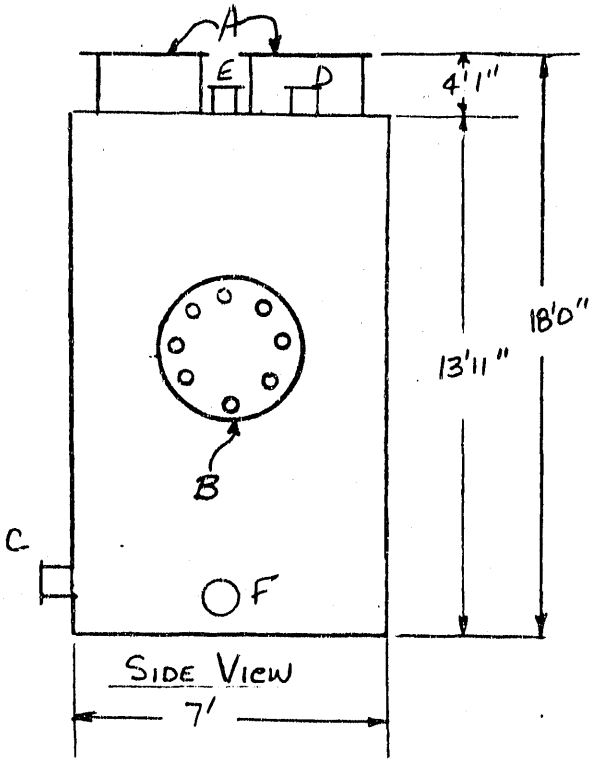
MATERIALS

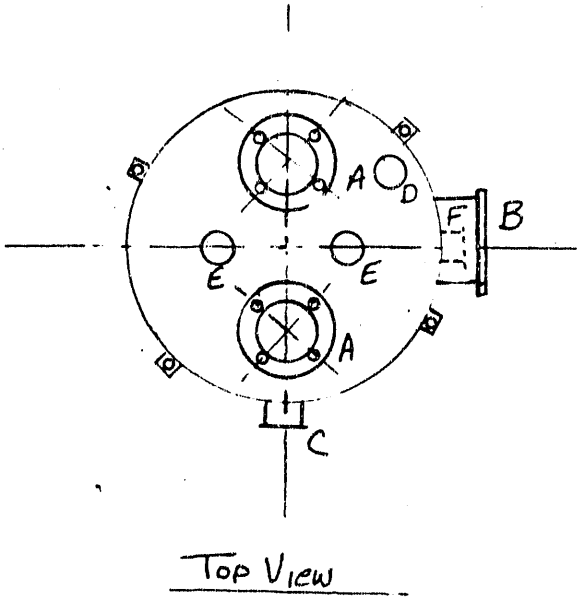
	Item	Thickness	Mat'l Class	Mat'l - Minimum Quality
24				
25	Shell	* in.		Carbon steel
26	Heads	* in.		Carbon Steel
27	Lining	in.		EPOXY (INSIDE)
28		in.		
29		in.		
30	Nozzle Necks			Carbon Steel
31	Flanges			Carbon Steel
32	Coupling			Carbon Steel
33	M.H. Cover			Carbon Steel
34	Supports			Carbon Steel
35	Bolts/Studs			Carbon Steel
36	Nuts			Carbon Steel
37	Gaskets			

NOZZLE SCHEDULE

	Service	Mark	No.	Size	Rating	Face	Type
38							
39	TURBINE PUMP	A	2	25"	150 lb	FF	Flg
40	MANWAY	B	1	24"	150 lb	RF	Flg
41	INLET	C	1	10"	150 lb	RF	Flg
42	VENT	D	1	10"	150 lb	RF	Flg
43	Level Control	E	2	4"	150 lb	RF	Flg
44	DRAIN	F	1	4"	150 lb	RF	Flg
45		G					
46		H					
47		J					
48		K					
49		L					
50		M					
51		N					
52		P					
53		Q					
54		R					
55	Nozzle to be Plugged or Blinded — * *						

VESSEL SKETCH





For Further Details, See Sheet No.

CORPORATION	EQUIPMENT NAME: DEGAS TANK	EQUIPMENT NO.: T-2003
BY: R.L. ANDERSON	VERTICAL VESSEL - SPECIFICATION	AREA NO.: 20
CHECKED: [illegible]		AREA NAME: GROUNDWATER TREATMENT SYSTEM
APP'D: [illegible]	REVISION: A 2/21/91 / B 3/20/91 / C	
DATE: 2/21/91	VENDOR TO COMPLETE INFORMATION MARKED *	SHEET 13 OF 17

COMPANY NAME: Wright-Patterson Air Force Base	**PROJECT NO:** 199814
PROJECT NAME: Ground Water Treatment System	**CHARGE NO:** 199814.05.03.01
LOCATION: WPAFB, Ohio	

TYPE: Fine Bubble Diffusers Installed on CPVC Piping

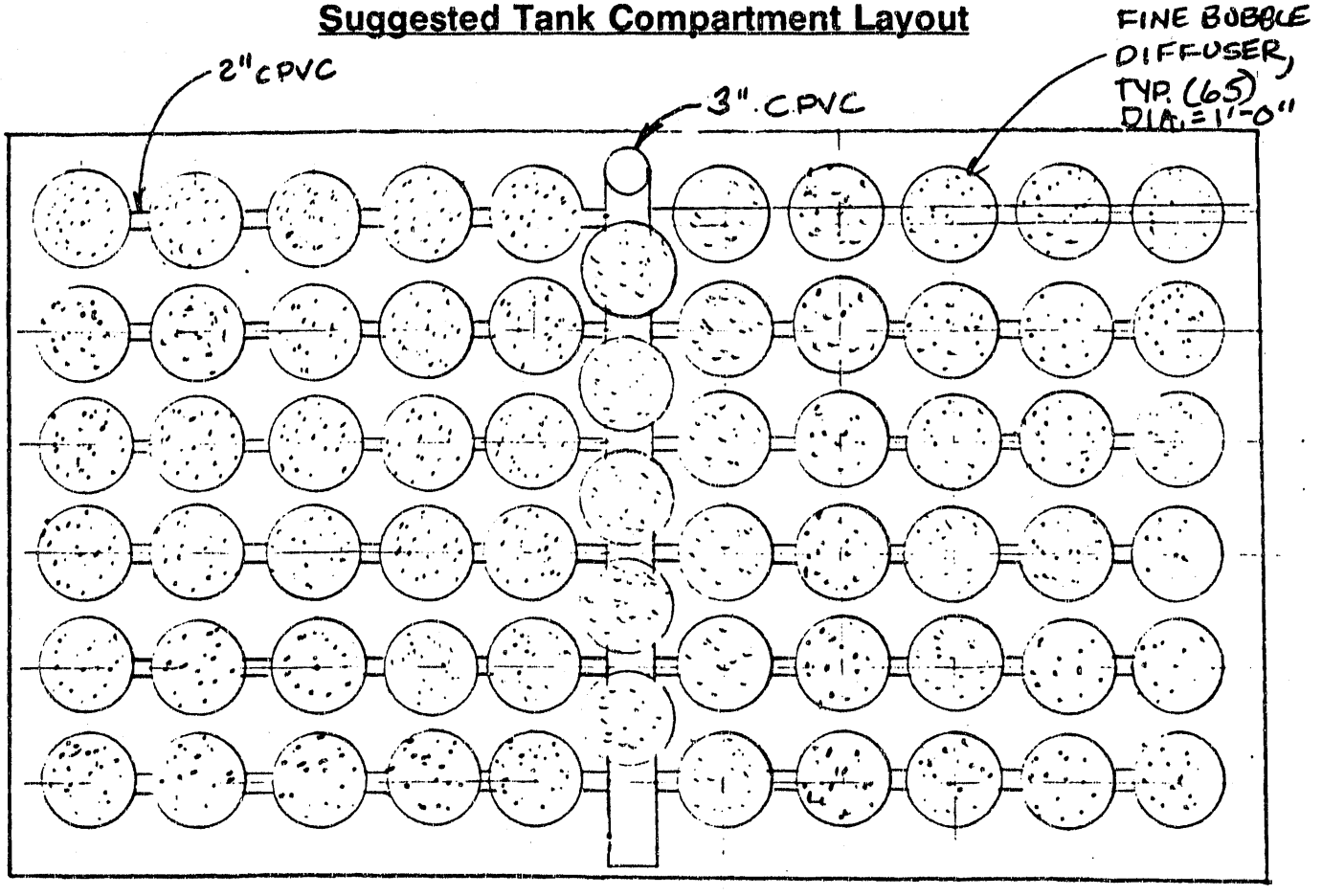
NUMBER OF UNITS: 3 (One System per Compartment)

SERVICE CONDITIONS

Air Flow Rater Per Diffuser: 8 CFM (Minimum)
Pressure Drop Per Diffuser: 15" H_2O (Maximum)
Air Flow Rate From System: 500 ACFM
Material: Elastomer Type
Minimum Space Between Diffusers: 1"
Minimum Distance From Tank Walls: 3"
Leak-Proof When Not In Operation

DIFFUSERS & PIPING ARRANGEMENT

Suggested Tank Compartment Layout



DRAFT	**EQUIPMENT NAME** Primary Diffuser System	**EQUIPMENT NO.** Z-2001 A-C
BY: J. Becker	**MISCELLANEOUS EQUIPMENT SPECIFICATION**	**AREA NO.** 20
CHECKED: RWH		**AREA NAME** Ground Water Treatment System
APP'D: D H Engel	**REVISION** 2/22/91 |A| 3/20/91 |B| |C|	
DATE: 3/20/91	VENDOR TO COMPLETE OR CONFIRM INFORMATION MARKED *	**SHEET** 14 **OF** 17

COMPANY NAME: Wright-Patterson Air Force Base	**PROJECT NO:** 199814
PROJECT NAME: Ground Water Treatment System	**CHARGE NO:** 199814.05.03.01
LOCATION: WPAFB, Ohio	

TYPE: Fine Bubble Diffusers Installed on CPVC Piping

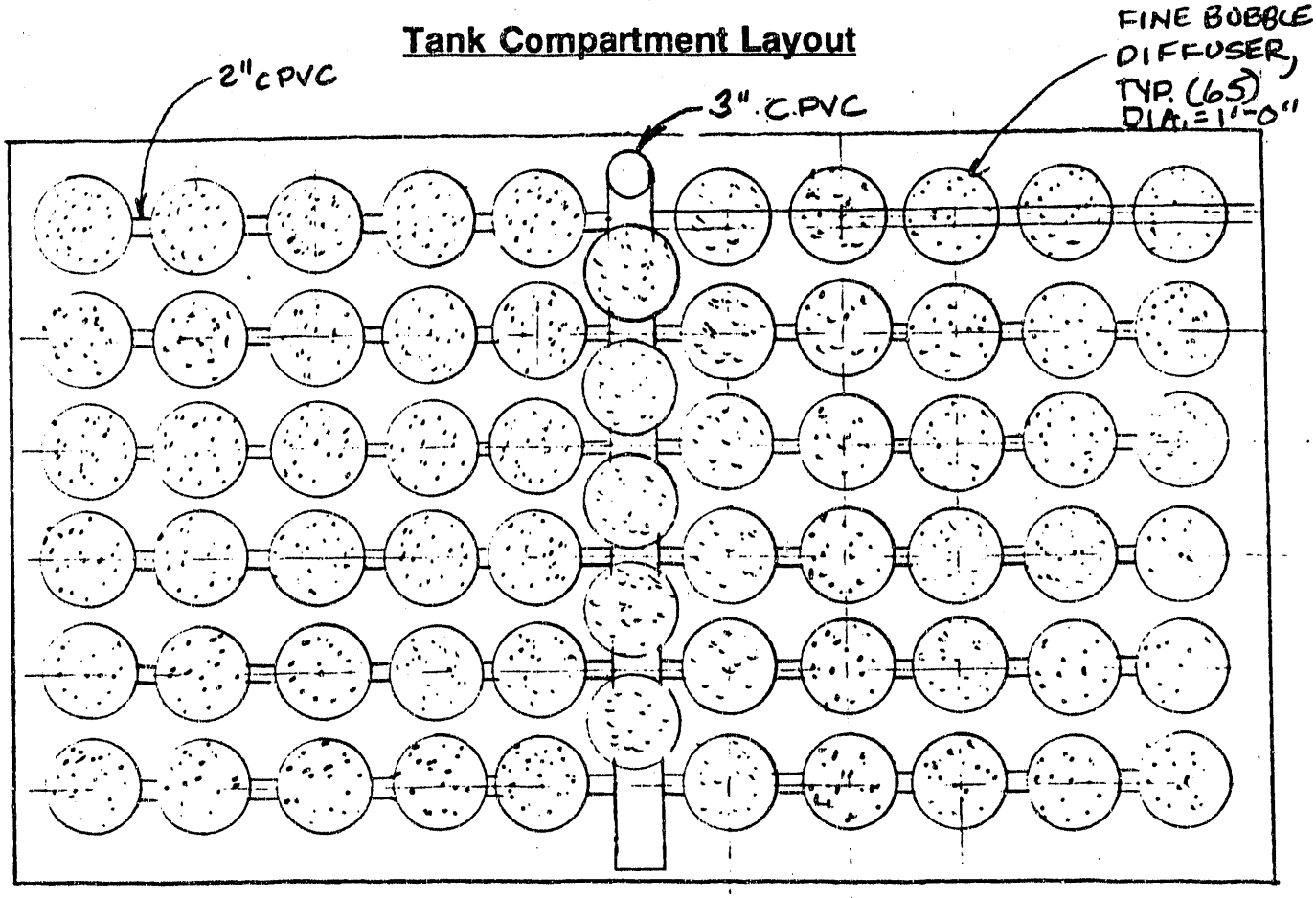
NUMBER OF UNITS: 3 (One System per Compartment)

SERVICE CONDITIONS

Air Flow Rater Per Diffuser: 8 CFM (Minimum)
Pressure Drop Per Diffuser: 15" H_2O (Maximum)
Air Flow Rate From System: 500 ACFM
Material: Elastomer Type
Maximum Space Between Diffusers: 8"
Minimum Space Between Diffusers: 1"
Maximum Distance From Tank Walls: 1' - 0"
Minimum Distance From Tank Walls: 3"
Leak-Proof When Not in Operation

DIFFUSERS & PIPING ARRANGEMENT

Tank Compartment Layout



DRAFT	**EQUIPMENT NAME** Secondary Diffuser System	**EQUIPMENT NO.** Z-2002 A-C
BY: J. Becker	**MISCELLANEOUS EQUIPMENT SPECIFICATION**	**AREA NO.** 20
CHECKED: DWH		**AREA NAME** Ground Water Treatment System
APP'D: DH. Ewald	**REVISION** 2/22/91 |A| 3/20/91 |B| |C|	
DATE: 3/20/91	VENDOR TO COMPLETE OR CONFIRM INFORMATION MARKED *	**SHEET** 15 **OF** 17

COMPANY NAME: Wright-Patterson Air Force Base	PROJECT NO: 199814
PROJECT NAME: Ground Water Treatment System	CHARGE NO: 199814.05.03.01
LOCATION: WPAFB, Ohio	

TYPE: Vertical In-Line Eliminator

NUMBER OF UNITS: 2

SERVICE CONDITIONS

Air Velocity: 12.5 FT/S
Air Flow Rate: 500 ACFM
Temperature: 55° F - 65° F

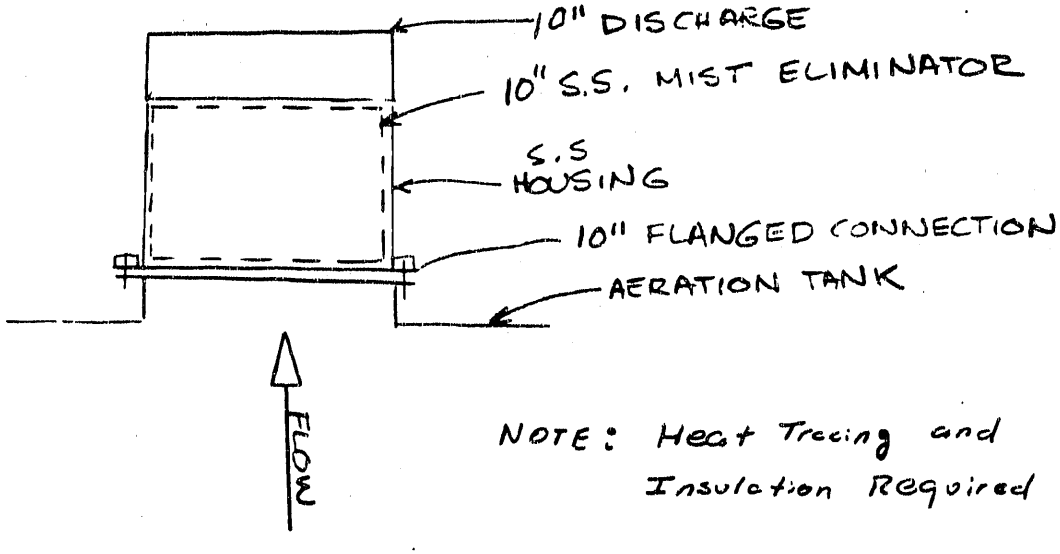
MIST ELIMINATOR

Removable Housing and Mist Eliminator
Housing Inlet & Outlet: 10" SS Ducting
Pressure Drop: < 1" H_2O
Removal Efficiency: 99+% of Particles > 10 μm

MATERIALS OF CONSTRUCTION

Stainless Steel

INSTALLATION CONFIGURATION



DRAFT	EQUIPMENT NAME: Primary Demister	EQUIPMENT NO.: Z-2003 A,B
BY: J. Becker	MISCELLANEOUS EQUIPMENT SPECIFICATION	AREA NO. 20
CHECKED: DH Engel		AREA NAME: Ground Water Treatment System
APP'D: RWH	REVISION 2/22/91 |A| 3/20/91 |B| 1/31/92 |0|	
DATE:	VENDOR TO COMPLETE OR CONFIRM INFORMATION MARKED *	SHEET 16 OF 17

COMPANY NAME: Wright-Patterson Air Force Base	**PROJECT NO:** 199814
PROJECT NAME: Ground Water Treatment System	**CHARGE NO:** 199814.05.03.01
LOCATION: WPAFB, Ohio	

TYPE: Vertical In-Line Mist Eliminator

NUMBER OF UNITS: 2

SERVICE CONDITIONS

Air Velocity: 12.5 FT/S
Air Flow Rate: 500 ACFM
Temperature: 55° F - 65° F

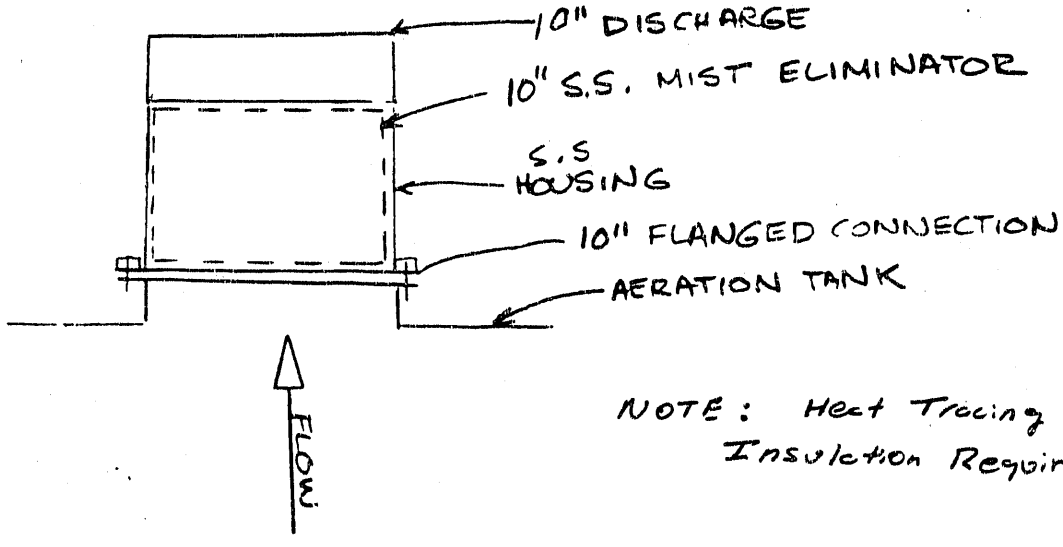
MIST ELIMINATOR

Removable Housing and Mist Eliminator
Housing Inlet & Outlet: 10" SS Ducting
Pressure Drop: < 1" H_2O
Removal Efficiency: 99+% of Particles > 10 μm

MATERIALS OF CONSTRUCTION

Stainless Steel

INSTALLATION CONFIGURATION



NOTE: Heat Tracing and Insulation Required

DRAFT	**EQUIPMENT NAME** Secondary Demister	**EQUIPMENT NO.** Z-2004 A,B
BY: J. Becker	**MISCELLANEOUS EQUIPMENT SPECIFICATION**	**AREA NO.** 20
CHECKED: DH Engel		**AREA NAME** Ground Water Treatment System
APP'D:	**REVISION** 2/22/91 |A| 3/20/91 |B| 7/31/92 |C|	
DATE:	**VENDOR TO COMPLETE OR CONFIRM INFORMATION MARKED ***	**SHEET** 17 **OF** 17

5.0 PIPE LINE LIST

Pipe line lists are used to list and describe all pipe lines on the P&IDs and give information clarifying the specifications and operating conditions of each line. The pipe line list (Table 5-2) consists of line number and size, specification letter (see Table 5-2), description of the fluid flowing through the line, origination and destination of the line, P&ID drawing number designation, an indication of whether or not the line is to be insulated and heat traced, and the operating and design temperature and pressure.

5.1 FORMAT NOTES FOR THE PIPING LINE LIST

The pipe line number has the following format:

```
MS - 32 01 - 4" - C
|    |  |    |    |
|    |  |    |    Pipe Specification Table (Table 5-2)
|    |  |    |
|    |  |    Line Size
|    |  |
|    |  Consecutive Number
|    |
|    Area Number (See area number description in Section 10.0 - Drawing List)
|
Line Service Designation Code (Table 5-1)
```

These line numbers were used during the process design and will continue to be used during the detailed design. Lines not on the current P&IDs that were on previous revisions are canceled lines and will be designated as "not used" in the last column of the Piping Line List to avoid error in the numbering sequence.

Table 5-1 presents the Line Service Descriptions applicable for this process design. Table 5-2 presents the IT Specification Table showing letters designating material specifications for pipes. Table 5-3 presents the Pipe Line List for this process design.

TABLE 5-1. LINE SERVICE DESIGNATION

Code	Service	Piping Spec.
	Air Systems	
AA	Ambient air	W
	Drain Systems	
LW	Drain	N
WW	Final effluent	AJ
	Vent Systems	
EC	Vent gas	Q, W
	Water Systems	
WW	Wastewater	J, N
TW	Rainwater/storm water	N

TABLE 5-2. IT PIPING SPECIFICATION TABLE

Service	Material (Max. Press./Max. Temp.)	Specification Letter
Underground Influent	PVC (see spec)	J
Wastewater (above ground)	Carbon steel (125 psig/180°F)	N
Ambient Air, Vent Air	316L Stainless steel, (ductwork)	Q
Ambient Air, Vent Air	CPVC (50 psig/195°F) (see spec.)	W
Underground Effluent Discharge	Polyethylene (see spec)	AJ

TABLE 5-3

PIPE LINE LIST

LINE NUMBER	LINE SIZE IN.	PIPE SPEC.	FLOWING MEDIUM	FROM	TO	P&ID DRAWING NO.	INS.	HEAT TRACE	OPERATING TEMP. °F	OPERATING PRES. psig	DESIGN TEMP. °F	DESIGN PRES. psig	REMARKS
WW-2000	6	J	Wastewater	P-2001	WW-2001	D01	---	---	55	56.5	≤ 140	100	
WW-2001	6	N	Wastewater	WW-2000	T-2001	D01, D02	X	X	55	56.5	180	125	
WW-2002	6	J	Wastewater	P-2004	WW-2003	D01	---	---	55	44.8	≤ 140	100	
WW-2003	6	N	Wastewater	WW-2002	T-2001	D01, D02	X	X	55	44.8	180	125	
WW-2004	6	J	Wastewater	P-2005	WW-2005	D01	---	---	55	44.8	≤ 140	100	
WW-2005	6	N	Wastewater	WW-2004	T-2001	D01, D02	X	X	55	44.8	180	125	
TW-2006	2	N	Rain/Storm Water	P-2002	T-2001	D01, D02	X	X	Ambient	7	180	125	
TW-2007	2	N	Rain/Storm Water	TW-2006	T-2002	D02, D03	X	X	Ambient	7	180	125	
WW-2008	6	N	Wastewater	WW-2001	T-2002	D02, D03	X	X	55	56.5	180	125	
WW-2009	6	N	Wastewater	WW-2003	T-2002	D02, D03	X	X	55	44.8	180	125	
WW-2010	6	N	Wastewater	WW-2005	T-2002	D02, D03	X	X	55	44.8	180	125	
LW-2011	4	N	Drain Water	T-2001	Drain	D02	X	---	55	4	180	125	
TW-2012	3	N	Rain/Storm Water	TW-2006	T-2002	D02	X	X	---	---	---	---	Not Used
AA-2013	6	W	Ambient Air	B-2001A	T-2001A	D02	---	---	Ambient	4	195	50	
AA-2014	6	W	Ambient Air	B-2001B	T-2001B	D02	---	---	Ambient	4	195	50	

REV	DESCRIPTION	DATE	BY
A	Issued for Draft PD	2/22/91	TSK
B	Issued for Draft PD	3/20/91	JAB
0	Issued for Final PD	1/31/92	WHS

COMPANY NAME: Wright-Patterson Air Force Base

PROJECT NAME: Ground Water Treatment System

PROJECT NO. 199814

CHARGE NO. .05.03.01

AREA NAME: Ground Water Treatment System

AREA NO. 20

LOCATION: WPAFB, Ohio

BY: R. Anderson

CHECKED: T. Kovalcson

APP'D: R. Helsel

DATE: 1/31/92

SHEET 4 OF 8

TABLE 5-3 (Continued)

PIPE LINE LIST

LINE NUMBER	LINE SIZE IN.	PIPE SPEC.	FLOWING MEDIUM	FROM	TO	P&ID DRAWING NO.	INS.	HEAT TRACE	OPERATING TEMP. °F	OPERATING PRES. psig	DESIGN TEMP. °F	DESIGN PRES. psig	REMARKS
AA-2015	6	W	Ambient Air	B-2001C	T-2001C	D02	---	---	Ambient	4	195	50	
EC-2016	10	Q	Vent Air	Z-2003A	EC-2022	D02	---	---	55	0	See Spec	See Spec	
EC-2017	10	Q	Vent Air	Z-2003B	EC-2022	D02	---	---	55	0	See Spec	See Spec	
EC-2018	10	W	Vent Air	T-2001	EC-2030	D02, D05	---	---	55	0	See Spec	See Spec	
WW-2019	10	N	Wastewater	T-2001	T-2002	D02, D03	X	X	55	4	180	125	
WW-2020	10	N	Wastewater	WW-2019	Drain	D02	X	X	55	4	180	125	
WW-2021	10	N	Wastewater	WW-2019	WW-2031	D02, D03	X	X	55	4	180	125	
EC-2022	12	W	Vent Air	EC-2017	B-2001A	D02, D05	---	---	Ambient	Max -1	195	50	
TW-2023	2	N	Rain/Storm Water	TW-2007	T-2003	D03, D04	X	X	Ambient	7	180	125	
AA-2024	6	W	Ambient Air	B-2002A	Z-2002A	D03	---	---	Ambient	4	195	50	
AA-2025	6	W	Ambient Air	B-2002B	Z-2002B	D03	---	---	Ambient	4	195	50	
AA-2026	6	W	Ambient Air	B-2002C	Z-2002C	D03	---	---	Ambient	4	195	50	
LW-2027	4	N	Ambient Water	T-2002	Drain	D03	X	---	55	4	180	125	
EC-2028	10	W	Vent Air	Z-2004A	EC-2033	D03	---	---	55	0	See Spec	See Spec	
EC-2029	10	W	Vent Air	Z-2004B	EC-2033	D03	---	---	55	0	See Spec	See Spec	

		REV	DESCRIPTION	DATE	BY	
COMPANY NAME: Wright-Patterson Air Force Base						BY: R. Anderson
PROJECT NAME: Ground Water Treatment System	PROJECT NO. 199814	A B O	Issued for Draft PD Issued for Draft PD Issued for Final PD	2/22/91 3/20/91 1/31/92	TSK JAB WHS	CHECKED: T. Kovalcson
	CHARGE NO. .05.03.01					APP'D: R. Heisel
AREA NAME: Ground Water Treatment System	AREA NO. 20					DATE: 1/31/92
LOCATION: WPAFB, Ohio						SHEET 5 OF 8

TABLE 5-3 (Continued)

PIPE LINE LIST

LINE NUMBER	LINE SIZE IN.	PIPE SPEC.	FLOWING MEDIUM	FROM	TO	P&ID DRAWING NO.	INS.	HEAT TRACE	OPERATING TEMP. °F	OPERATING PRES. psig	DESIGN TEMP. °F	DESIGN PRES. psig	REMARKS
EC-2030	10	W	Vent Air	T-2002	EC-2055	D03, D05	---	---	55	0	See Spec	See Spec	
WW-2031	10	N	Wastewater	T-2002	T-2003	D03, D04	X	X	55	4	180	125	
WW-2032	10	N	Wastewater	WW-2031	Drain	D03	X	X	55	4	180	125	
EC-2033	12	W	Vent Air	EC-2029	EC-2022	D03, D05	---	---	Ambient	0	See Spec	See Spec	
WW-2034	4	N	Wastewater	T-2003	Drain	D04	X	X	55	4	180	125	
WW-2035	10	N	Wastewater	WW-2034	Drain	D04	X	X	55	4	180	125	
EC-2036	10	W	Vent Air	T-2003	EC-2030	D04, D05	---	---	55	0	See Spec	See Spec	
WW-2037	10	N	Wastewater	P-2003A	WW-2039	D04	X	X	55	31	180	125	
WW-2038	10	N	Wastewater	P-2003B	WW-2037	D04	X	X	55	31	180	125	
WW-2039	10	AJ	Wastewater	WW-2037	Outfall	D04	---	---	55	31	200	500	~ 3000' to Mad River
WW-2040	6	N	Wastewater	WW-2037	T-2001	D02, D04	X	X	55	31	180	125	
EC-2041	12	W	Vent Air	EC-2033	EC-2030	D05	---	---	Ambient	0	See Spec	See Spec	
EC-2042	12	W	Vent Air	EC-2022	B-2003B	D05	---	---	Ambient	1	See Spec	See Spec	
EC-2043	12	W	Vent Air	B-2003B	EC-2044	D05	---	---	Ambient	4	195	50	
EC-2044	12	W	Vent Air	B-2003A	C-2001A	D05	---	---	Ambient	4	See Spec	See Spec	

COMPANY NAME: Wright-Patterson Air Force Base		REV	DESCRIPTION	DATE	BY
PROJECT NAME: Ground Water Treatment System	PROJECT NO. 199614	A	Issued for Draft PD	2/22/91	TSK
	CHARGE NO. .05.03.01	B	Issued for Draft PD	3/20/91	JAB
AREA NAME: Ground Water Treatment System	AREA NO. 20	0	Issued for Final PD	1/31/92	WHS
LOCATION: WPAFB, Ohio					

BY: R. Anderson
CHECKED: T. Kovalcson
APP'D: R. Helsel
DATE: 1/31/92
SHEET 6 OF 8

TABLE 5-3 (Continued)

PIPE LINE LIST

LINE NUMBER	LINE SIZE IN.	PIPE SPEC.	FLOWING MEDIUM	FROM	TO	P&ID DRAWING NO.	INS.	HEAT TRACE	OPERATING TEMP. °F	OPERATING PRES. psig	DESIGN TEMP. °F	DESIGN PRES. psig	REMARKS
EC-2045	10	M	Vent Air	EC-2044	C-2001A	D05	X	—	Ambient	4	150	20	Not Used
EC-2046	10	M	Vent Air	C-2001A	EC-2049	D05	X	—	Ambient	< 3	150	20	Not Used
EC-2047	10	W	Vent Air	EC-2046	EC-2048	D05	X	—	Ambient	< 3	195	50	Not Used
EC-2048	10	M	Vent Air	EC-2047	EC-2049	D05	X	—	Ambient	< 3			Not Used
EC-2049	10	W	Vent Air	C-2001A	C-2001B	D05	—	—	Ambient	< 3	195	50	
EC-2050	10	M	Vent Air	EC-2049	EC-2051	D05	X	—	Ambient	< 3			Not Used
EC-2051	10	W	Vent Air	EC-2050	EC-2052	D05	X	—	Ambient	< 3	195	50	Not Used
EC-2052	10	M	Vent Air	EC-2050	C-2001B	D05	X	—	Ambient	< 3	150	20	Not Used
EC-2053	10	M	Vent Air	C-2001B	EC-2054	D05	X	—	Ambient	< 3	150	20	Not Used
EC-2054	12	W	Vent Air	C-2001B	EC-2055	D05	—	—	Ambient	6"H_2O	See Spec	See Spec	
EC-2055	20	W	Vent Air	EC-2067 EC-2054	Atmosphere	D05	—	—	Ambient	3"H_2O	See Spec	See Spec	
EC-2056	10	Q	Vent Air	T-2001	Z-2003A	D02	—	—	Ambient	3"H_2O	See Spec	See Spec	
EC-2057	10	Q	Vent Air	T-2001	Z-2003B	D02	—	—	Ambient	3"H_2O	See Spec	See Spec	
EC-2058	10	Q	Vent Air	T-2002	Z-2004A	D03	—	—	Ambient	3"H_2O	See Spec	See Spec	
EC-2059	10	Q	Vent Air	T-2002	Z-2004B	D03	—	—	Ambient	3"H_2O	See Spec	See Spec	

COMPANY NAME: Wright-Patterson Air Force Base		REV	DESCRIPTION	DATE	BY	BY: R. Anderson
PROJECT NAME: Ground Water Treatment System	PROJECT NO. 199814	A	Issued for Draft PD	2/22/91	TSK	CHECKED: T. Kovalcson
	CHARGE NO. .05.03.01	B	Issued for Draft PD	3/20/91	JAB	APPD: R. Helsel
AREA NAME: Ground Water Treatment System	AREA NO. 20	O	Issued for Final PD	1/31/92	WHS	DATE: 1/31/92
LOCATION: WPAFB, Ohio						SHEET 7 OF 8

TABLE 5-3 (Continued)

PIPE LINE LIST

LINE NUMBER	LINE SIZE IN.	PIPE SPEC.	FLOWING MEDIUM	FROM	TO	P&ID DRAWING NO.	INS.	HEAT TRACE	OPERATING TEMP. °F	OPERATING PRES. psig	DESIGN TEMP. °F	DESIGN PRES. psig	REMARKS
WW-2060	6	N	Wastewater	WW-2019	WW-2040	D02	X	X	55	4	180	125	
EC-2061	12	W	Vent Air	EC-2044	EC-2064	D05	—	—	Ambient	< 3	See Spec	See Spec	
EC-2062	12	W	Vent Air	EC-2065	EC-2064	D05	—	—	Ambient	< 3	See Spec	See Spec	
EC-2063	12	W	Vent Air	EC-2044	EC-2064	D05	—	—	Ambient	< 3	See Spec	See Spec	
EC-2064	12	W	Vent Air	EC-2061	EC-2063	D05	—	—	Ambient	< 3	See Spec	See Spec	
EC-2065	12	W	Vent Air	EC-2056	EC-2054	D05	—	—	Ambient	< 3	See Spec	See Spec	
EC-2066	12	W	Vent Air	EC-2065	EC-2054	D05	—	—	Ambient	< 3	See Spec	See Spec	
EC-2067	16	W	Vent Air	EC-2041	EC-2055	D05	—	—	55	0	See Spec	See Spec	

REV	DESCRIPTION	DATE	BY
A	Issued for Draft PD	2/22/91	TSK
B	Issued for Draft PD	3/20/91	JAB
0	Issued for Final PD	1/31/92	WHS

COMPANY NAME: Wright-Patterson Air Force Base

PROJECT NAME: Ground Water Treatment System

PROJECT NO. 199814

CHARGE NO. .05.03.01

AREA NAME: Ground Water Treatment System

AREA NO. 20

LOCATION: WPAFB, Ohio

BY: R. Anderson

CHECKED: T. Kovalcson

APPD: R. Helsel

DATE: 1/31/92

SHEET 8 OF 8

6.0 INSTRUMENT LIST

A tabulation of all instruments was prepared as part of the PD to provide a basis for subsequent engineering design work by instrument and electrical engineering specialists. All sensing instruments, control valves, safety devices, etc. are assigned unique instrument numbers. This list identifies the instrument's location, service, and number. Location of the instrument is defined on the instrument list by the letter designations "F" for field, "C" for control panel, and "R" for remote (accessed through the automatic phone dialer [APD]). The service description indicates the location of the instrument in the system. The instrument numbering (tagging) system is described below.

6.1 INSTRUMENT TAGGING SYSTEM

In the instrument tagging system, instruments are categorized and assigned individual consecutive numbers by the following five categories:

	Consecutive Number
Pressure	001-200
Flow	201-300
Level	301-400
Temperature	401-500
Miscellaneous	501-999

Consecutive numbers are begun again in each area. All instruments in a control loop are assigned the same consecutive number as the main controlling category.

Format

The complete instrument tag number must have the instrument identification code plus the consecutive number.

XXXXNNND

where:

"X" = alphabetic instrument identification code (as per the ISA standard instrument nomenclature as shown on P&ID lead sheets for the job),
"N" = consecutive instrument loop number, and
"D" = similar instrument identifier within the same loop (A, B, C, etc.).

Instruments are numbered using the following rules:

1. All instruments in a control loop are assigned the same consecutive number. One type of loop would be instruments linked by an electrical signal.

2. All the instruments involved in positioning a valve also form a loop.

3. The instruments in an interlock do not form a loop unless linked on the P&ID by an electrical signal.

4. If a loop contains instruments from more than one of the five categories, all the instruments in the loop are assigned a consecutive number appropriate to the instruments of the main or controlling category.

5. Two or more instruments of the same instrument identification code within a loop are distinguished by suffixing the consecutive numbers with A, B, etc.

6. If instruments are canceled after a number has been assigned, the number is designated as "not used" in the last column of the Instrument List to avoid errors in the numbering sequence.

6.2 INSTRUMENT LIST

Table 6-1 presents the instrument list for the process design.

TABLE 6-1

LOOP DESCRIPTION	LOOP NUMBER	SERVICE DESCRIPTION	LOCATION	P&ID NUMBER	REMARKS
PI	001	EXTRACTION WELL #1 PUMP DISCHARGE	F	20-D01	
PI	002	EXTRACTION WELL #2 PUMP DISCHARGE	F	20-D01	
PI	003	EXTRACTION WELL #3 PUMP DISCHARGE	F	20-D01	
PI	004	BLOWER B-2001A	F	20-D02	
PI	005	BLOWER B-2001B	F	20-D02	
PI	006	BLOWER B-2001C	F	20-D02	
PIC	007	OUTLET FROM T-2001 OR 2 AND B-2003A,B	C	20-D05	
PR	007	RECORDER FOR 007 CONTROL LOOP	C	20-D05	
PT	007 A	T-2001 (STAGE 1)	F	20-D02	
PT	007 B	T-2001 (STAGE 2)	F	20-D02	
PT	007 C	T-2002 (STAGE 4)	F	20-D03	
PT	007 D	T-2002 (STAGE 5)	F	20-D03	
PY	007 A	SWITCH FOR PT-007A,B AND AVERAGER	C	20-D02	
PY	007 B	SWITCH FOR PY-007A,C	C	20-D05	
PY	007 C	SWITCH FOR PT-007C,D AND AVERAGER	C	20-D03	
PY	007 D	SWITCH FOR B-2003A,B, MOTORS	C	20-D05	
PI	008	BLOWER B-2002A	F	20-D03	
PI	009	BLOWER B-2002B	F	20-D03	
PI	010	BLOWER B-2002C	F	20-D03	
PI	011	OUTLET FROM P-2003A	F	20-D04	
PI	012	OUTLET FROM P-2003B	F	20-D04	
PI	013	INLET TO B-2003A,B	F	20-D05	
PI	014	OUTLET FROM B-2003A,B	F	20-D05	
DPAHH	015	INLET AND OUTLET OF C-2001A,B	R	20-D05	
DPI	015	INLET AND OUTLET OF C-2001A,B	C	20-D05	
DPR	015	RECORDER FOR 015 LOOP	C	20-D05	
DPT	015	INLET AND OUTLET OF C-2001A,B	F	20-D05	
PI	016	OUTLET FROM C-2001A,B	F	20-D05	
PP	017	VENT OUTLET FROM STAGE 1 T-2001	F	20-D02	
PP	018	VENT OUTLET FROM STAGE 2 T-2001	F	20-D02	

TABLE 6-1 (CONTINUED)

LOOP DESCRIPTION	LOOP NUMBER	SERVICE DESCRIPTION	LOCATION	P&ID NUMBER	REMARKS
PP	019	VENT OUTLET FROM STAGE 3 T-2001	F	20-D02	
PP	020	VENT OUTLET FROM STAGE 4 T-2002	F	20-D03	
PP	021	VENT OUTLET FROM STAGE 5 T-2002	F	20-D03	
PP	022	VENT OUTLET FROM STAGE 6 T-2002	F	20-D03	
DPAHH	023	INLET & OUTLET OF Z-2003A,B	R	20-D02	
DPI	023	INLET & OUTLET OF Z-2003 A,B	C	20-D02	
DPR	023	RECORDER FOR 023 LOOP	C	20-D02	
DPT	023 A	INLET OF Z-2003A	F	20-D02	
DPT	023 B	INLET OF Z-2003B	F	20-D02	
DPT	023 C	OUTLET OF Z-2003A	F	20-D02	
DPT	023 D	OUTLET OF Z-2003B	F	20-D02	
DPY	023 A	SWITCH FOR DPT-023A,B	C	20-D02	
DPY	023 B	SWITCH FOR DPT-023C,D	C	20-D02	
DPAHH	024	INLET & OUTLET OF Z-2004A,B	R	20-D03	
DPI	024	INLET & OUTLET OF Z-2004A,B	C	20-D03	
DPR	024	RECORDER FOR 024 LOOP	C	20-D03	
DPT	024 A	INLET OF Z-2004A	F	20-D03	
DPT	024 B	INLET OF Z-2004B	F	20-D03	
DPT	024 C	OUTLET OF Z-2004A	F	20-D03	
DPT	024 D	OUTLET OF Z-2004B	F	20-D03	
DPY	024 A	SWITCH FOR DPT-024A,B	C	20-D03	
DPY	024 B	SWITCH FOR DPT-024C,D	C	20-D03	
FE	201	GW FROM EXTRACTION WELL #1	F	20-D01	
FI	201	GW FROM EXTRACTION WELL #1	C	20-D01	
FQR	201	RECORDER - GW FROM EXTRACTION WELL #1	C	20-D01	
FR	201	RECORDER - GW FROM EXTRACTION WELL #1	C	20-D01	
FT	201	GW FROM EXTRACTION WELL #1	F	20-D01	
FE	202	GW FROM EXTRACTION WELL #2	F	20-D01	
FI	202	GW FROM EXTRACTION WELL #2	C	20-D01	

TABLE 6-1 (CONTINUED)

LOOP DESCRIPTION	LOOP NUMBER	SERVICE DESCRIPTION	LOCATION	P&ID NUMBER	REMARKS
FQR	202	RECORDER - GW FROM EXTRACTION WELL #2	C	20-D01	
FR	202	RECORDER - GW FROM EXTRACTION WELL #2	C	20-D01	
FT	202	GW FROM EXTRACTION WELL #2	F	20-D01	
FE	203	GW FROM EXTRACTION WELL #3	F	20-D01	
FI	203	GW FROM EXTRACTION WELL #3	C	20-D01	
FQR	203	RECORDER - GW FROM EXTRACTION WELL #3	C	20-D01	
FR	203	RECORDER - GW FROM EXTRACTION WELL #3	C	20-D01	
FT	203	GW FROM EXTRACTION WELL #3	F	20-D01	
FAHH	204	BLOWER B-2001A	R	20-D02	
FALL	204	BLOWER B-2001A	R	20-D02	
FE	204	BLOWER B-2001A	F	20-D02	
FI	204	BLOWER B-2001A	C	20-D02	
FR	204	RECORDER - BLOWER B-2001A	C	20-D02	
FT	204	BLOWER B-2001A	F	20-D02	
FAHH	205	BLOWER B-2001B	R	20-D02	
FALL	205	BLOWER B-2001B	R	20-D02	
FE	205	BLOWER B-2001B	F	20-D02	
FI	205	BLOWER B-2001B	C	20-D02	
FR	205	RECORDER - BLOWER B-2001B	C	20-D02	
FT	205	BLOWER B-2001B	F	20-D02	
FAHH	206	BLOWER B-2001C	R	20-D02	
FALL	206	BLOWER B-2001C	R	20-D02	
FE	206	BLOWER B-2001C	F	20-D02	
FI	206	BLOWER B-2001C	C	20-D02	
FR	206	RECORDER - BLOWER B-2001C	C	20-D02	
FT	206	BLOWER B-2001C	F	20-D02	
FAHH	207	OVERFLOW FROM TANK T-2001	R	20-D02	

TABLE 6-1 (CONTINUED)

LOOP DESCRIPTION	LOOP NUMBER	SERVICE DESCRIPTION	LOCATION	P&ID NUMBER	REMARKS
FSHH	207	OVERFLOW FROM TANK T-2001	F	20-D02	
FAHH	208	BLOWER B-2002A	R	20-D03	
FALL	208	BLOWER B-2002A	R	20-D03	
FE	208	BLOWER B-2002A	F	20-D03	
FI	208	BLOWER B-2002A	C	20-D03	
FR	208	RECORDER - BLOWER B-2002A	C	20-D03	
FT	208	BLOWER B-2002A	F	20-D03	
FAHH	209	BLOWER B-2002B	R	20-D03	
FALL	209	BLOWER B-2002B	R	20-D03	
FE	209	BLOWER B-2002B	F	20-D03	
FI	209	BLOWER B-2002B	C	20-D03	
FR	209	RECORDER - BLOWER B-2002B	C	20-D03	
FT	209	BLOWER B-2002B	F	20-D03	
FAHH	210	BLOWER B-2002C	R	20-D03	
FALL	210	BLOWER B-2002C	R	20-D03	
FE	210	BLOWER B-2002C	F	20-D03	
FI	210	BLOWER B-2002C	C	20-D03	
FR	210	RECORDER - BLOWER B-2002C	C	20-D03	
FT	210	BLOWER B-2002C	F	20-D03	
FAHH	211	OVERFLOW FROM TANK T-2002	R	20-D03	
FSHH	211	OVERFLOW FROM TANK T-2002	F	20-D03	
FE	212	TREATED EFFLUENT TO OUTFALL AT MAD RIVER	F	20-D04	
FI	212	TREATED EFFLUENT TO OUTFALL AT MAD RIVER	C	20-D04	
FQR	212	RECORDER - TREATED EFFLUENT	C	20-D04	
FR	212	RECORDER - TREATED EFFLUENT	C	20-D04	
FT	212	TREATED EFFLUENT TO OUTFALL AT MAD RIVER	F	20-D04	
FAHH	213	OVERFLOW FROM TANK T-2003	R	20-D04	
FSHH	213	OVERFLOW FROM TANK T-2003	F	20-D04	

TABLE 6-1 (CONTINUED)

LOOP DESCRIPTION	LOOP NUMBER	SERVICE DESCRIPTION	LOCATION	P&ID NUMBER	REMARKS
LE	301	EXTRACTION WELL #1	F	20-D01	
LSHL	301	GW FROM EXTRACTION WELL #1	F	20-D01	
LE	302	EXTRACTION WELL #2	F	20-D01	
LSHL	302	GW FROM EXTRACTION WELL #2	F	20-D01	
LE	303	EXTRACTION WELL #3	F	20-D01	
LSHL	303	GW FROM EXTRACTION WELL #3	F	20-D01	
LAHH	304	SUMP	R	20-D01	
LE	304	SUMP	F	20-D01	
LI	304	SUMP	C	20-D01	
LT	304	SUMP	F	20-D01	
LAHH	305 A	REDUNDANT SENSOR IN T-2003	C	20-D04	
LAHH	305 B	REDUNDANT SENSOR IN T-2003	R	20-D04	
LE	305	REDUNDANT SENSOR IN T-2003	F	20-D04	
LSHH	305	REDUNDANT SENSOR IN T-2003	F	20-D04	
LE	306	TREATED WATER DISCHARGE	F	20-D04	
LIC	306	TREATED WATER DISCHARGE	C	20-D04	
LT	306	TREATED WATER DISCHARGE	F	20-D04	
LV	306	TREATED WATER DISCHARGE	F	20-D04	
TI	401	TANK T-2001 WATER TEMP	F	20-D02	
TI	402	AIR DISCHARGE FROM STAGE 1	F	20-D02	
TI	403	TANK T-2002 WATER TEMP	F	20-D03	
TI	404	AIR DISCHARGE FROM STAGE 4	F	20-D03	
TI	405	TREATED EFFLUENT TO OUTFALL AT MAD RIVER	F	20-D04	
TI	406	INLET TO BLOWERS B-2003A,B	F	20-D05	
TI	407	EXHAUST FROM BLOWERS B-2003A,B	F	20-D05	
TI	408	OUTLET FROM C-2001B	F	20-D05	
HS	501 A	EXTRACTION WELL #1 PUMP P-2001	F	20-D01	
HS	501 B	EXTRACTION WELL #1 PUMP P-2001	C	20-D01	
HS	502 A	EXTRACTION WELL #2 PUMP P-2004	F	20-D01	
HS	502 B	EXTRACTION WELL #2 PUMP P-2004	C	20-D01	

TABLE 6-1 (CONTINUED)

LOOP DESCRIPTION	LOOP NUMBER	SERVICE DESCRIPTION	LOCATION	P&ID NUMBER	REMARKS
HS	503 A	EXTRACTION WELL #3 PUMP P-2005	F	20-D01	
HS	503 B	EXTRACTION WELL #3 PUMP P-2005	C	20-D01	
HS	504	BLOWER B-2001A	F	20-D02	
HS	505	BLOWER B-2001B	F	20-D02	
HS	506	BLOWER B-2001C	F	20-D02	
HS	507	BLOWER B-2002A	F	20-D03	
HS	508	BLOWER B-2002B	F	20-D03	
HS	509	BLOWER B-2002C	F	20-D03	
HS	510 A	SUMP PUMP P-2002	F	20-D01	
HS	510 B	SUMP PUMP P-2002	C	20-D01	
HS	511	PUMP P-2003A	F	20-D04	
HS	512	PUMP P-2003B	F	20-D04	
HS	513	VARIABLE SPEED MOTOR FOR BLOWER B-2003A	F	20-D05	
HS	514	VARIABLE SPEED MOTOR FOR BLOWER B-2003B	F	20-D05	
HS	515 A	EMERGENCY SWITCH	C	20-D01	
HS	515 B	EMERGENCY SWITCH	R	20-D01	REMOTE LOCATION TO BE DETERMINED

7.0 INSTRUMENT DATA SUMMARY SHEET

7.1 INTRODUCTION

These summary sheets provide the means to record various information relating to the operating requirements for each identified instrument or control element for each loop. This summary information is used by the instrument engineer in defining procurement specifications.

Instruments are arranged by category and assigned an individual consecutive number as outlined in Section 6.0, Instrument List. All instruments in a loop are assigned the same consecutive number. The instrument categories are as follows:

- Pressure
- Flow
- Level
- Temperature
- Miscellaneous

Summary sheets are presented in the following order:

Category	Type
Pressure	Instruments
	Control Valves
	Receiver Alarms/Switches
	Relief Valves

The other categories of flow, level, temperature, and miscellaneous all contain the above types of summary sheets with the exception of Relief Valves.

7.2 INSTRUMENT DATA SUMMARY SHEETS

The sheets presented in the following pages constitute the data known about the instrumentation of the GWTS at the time of the process design manual completion. Additional information will be developed during the detailed design.

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 2 OF 12

PRESSURE INSTRUMENTS

AREA NO. 20

TAG NO.	LOCATION	FLUID	PRESSURE PSI G		TEMPERATURE ° F		SPECIAL MATERIALS	P&ID NO.	REMARKS
			NORMAL	MAXIMUM	NORMAL	MAXIMUM			
PI-001	WW-2000-6"-J	Well Water	56.5	50	55	≤ 140	J	D01	
PI-002	WW-2002-6"-J	Well Water	44.8	50	55	≤ 140	J	D01	
PI-003	WW-2004-6"-J	Well Water	44.8	50	55	≤ 140	J	D01	
PI-004	AA-2013-6"-W	Ambient Air	4	50	Ambient	195	W	D02	
PI-005	AA-2014-6"-W	Ambient Air	4	50	Ambient	195	W	D02	
PI-006	AA-2015-6"-W	Ambient Air	4	50	Ambient	195	W	D02	
PIC-007	T-2001, T-2002 and B-2003A,B	Vent Air	-1<P<0	50	Ambient	195	W	D05	w/ PR-007, PT-007A-D and PY-007A-D
PI-008	AA-2024-6"-W	Ambient Air	4	50	Ambient	195	W	D03	
PI-009	AA-2025-6"-W	Ambient Air	4	50	Ambient	195	W	D03	
PI-010	AA-2026-6"-W	Ambient Air	4	50	Ambient	195	W	D03	
PI-011	WW-2037-10"-N	Effluent Water	31	125	55	180	N	D04	
PI-012	WW-2038-10"-N	Effluent Water	31	125	55	180	N	D04	
PI-013	EC-2022-12"-W	Vent Air	Max -1	50	Ambient	180	W	D05	
PI-014	EC-2044-12"-W	Vent Air	4	50	Ambient	180	W	D05	
DPI-015	EC-2044-12"-W EC-2054-12"-W	Vent Air	4	50	Ambient	180	W	D05	w/ DPR-015 and DPT-015
PI-016	EC-2054-12"-W	Vent Air	< 3	50	Ambient	180	W	D05	

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 3 OF 12

PRESSURE INSTRUMENTS

AREA NO. 20

TAG NO.	LOCATION	FLUID	PRESSURE PSI G		TEMPERATURE ° F		SPECIAL MATERIALS	P&ID NO.	REMARKS
			NORMAL	MAXIMUM	NORMAL	MAXIMUM			
PP-017	EC-2056-10"-Q	Vent Air	0	50	Ambient	195	Q	D02	
PP-018	EC-2057-10"-Q	Vent Air	0	50	Ambient	195	Q	D02	
PP-019	EC-2018-10"-W	Vent Air	0	50	Ambient	195	W	D02	
PP-020	EC-2058-10"-Q	Vent Air	0	50	Ambient	195	Q	D03	
PP-021	EC-2059-10"-Q	Vent Air	0	50	Ambient	195	Q	D03	
PP-022	EC-2030-10"-W	Vent Air	0	50	Ambient	195	W	D03	
DPI-023	EC-2056-10"-Q EC-2057-10"-Q EC-2016-10"-Q EC-2017-10"-Q	Vent Air					Q	D02	w/ DPR-023, DPT-023A-D and DPY-023A,B
DPI-024	EC-2058-10"-Q EC-2059-10"-Q EC-2028-10"-Q EC-2029-10"-Q	Vent Air					Q	D03	w/ DPR-024, DPT-024A-D and DPY-024A,B

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 4 OF 12

PRESSURE RECEIVER ALARMS/SWITCHES

AREA NO. 20

TAG NO.	LOCATION	ACTUATION POINT	TYPE		P&ID NO.	REMARKS
			HIGH	LOW		
DPAHH-015	Remote Phone		HH		D05	Activated by automatic phone dialer (APD)
DPAHH-023	Remote Phone		HH		D02	Activated by automatic phone dialer (APD)
DPAHH-024	Remote Phone		HH		D03	Activated by automatic phone dialer (APD)

INSTRUMENT DATA
SUMMARY SHEET

FLOW INSTRUMENTS

FLUID CODE	FLUID UNITS
L = LIQUID	gpm/(cfm)
S = STEAM	/HR.
G = GAS V = VAPOR	S __³/Hr. @ __°__ At 1 Atmosphere

PROJECT: 199814
DATE: 2/20/91
BY: Kovalcson
SHEET 5 OF 12

AREA NO. 20

TAG NO.	LINE SIZE	LINE NUMBER		TYPE OF METER	FLOW RATES			PRESSURE PSI G	TEMP. ° F	S.G. OR (MW)	VISC. (CP)	P&ID NO.	REMARKS
					NORMAL	MAXIMUM	START-UP OR UPSET						
FI-201	6"	WW-2001	L		200	600	50	56.5	55	1.0	1	D01	WITH FE-201, FQR-201, FR-201, AND FT-201
FI-202	6"	WW-2003	L		200	500	50	44.8	55	1.0	1	D01	WITH FE-202, FQR-202, FR-202, AND FT-202
FI-203	6"	WW-2005	L		200	500	50	44.8	55	1.0	1	D01	WITH FE-203, FQR-203, FR-203, AND FT-203
FI-204	6"	AA-2013	G		(400)	(540)	—	4	Ambient	(29)	—	D02	WITH FE-204, FR-204, AND FT-204
FI-205	6"	AA-2014	G		(400)	(540)	—	4	Ambient	(29)	—	D02	WITH FE-205, FR-205, AND FT-205
FI-206	6"	AA-2015	G		(400)	(540)	—	4	Ambient	(29)	—	D02	WITH FE-206, FR-206, AND FT-206
FI-208	6"	AA-2024	G		(400)	(540)	—	4	Ambient	(29)	—	D03	WITH FE-208, FR-208, AND FT-208
FI-209	6"	AA-2025	G		(400)	(540)	—	4	Ambient	(29)	—	D03	WITH FE-209, FR-209, AND FT-209
FI-210	6"	AA-2026	G		(400)	(540)	—	4	Ambient	(29)	—	D03	WITH FE-210, FR-210, AND FT-210
FI-212	10"	WW-2037	L		600	1600	50	31	55	1.0	1	D04	WITH FE-212, FQR-212, FR-212, AND FT-212

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 6 OF 12

FLOW RECEIVER ALARMS/SWITCHES

AREA NO. 20

TAG NO.	LOCATION	ACTUATION POINT	TYPE		P&ID NO.	REMARKS
			HIGH	LOW		
FAHH-204	Remote Phone		HH		D02	Activated by APD
FALL-204	Remote Phone			LL	D02	Activated by APD
FAHH-205	Remote Phone		HH		D02	Activated by APD
FALL-205	Remote Phone			LL	D02	Activated by APD
FAHH-206	Remote Phone		HH		D02	Activated by APD
FALL-206	Remote Phone			LL	D02	Activated by APD
FSHH-207	WW-2020-10"-N	Detection of Any Flow	HH		D02	
FAHH-207	Remote Phone	Detection of Any Flow	HH		D02	Activated by APD
FAHH-208	Remote Phone		HH		D03	Activated by APD
FALL-208	Remote Phone			LL	D03	Activated by APD
FAHH-209	Remote Phone		HH		D03	Activated by APD
FALL-209	Remote Phone			LL	D03	Activated by APD
FAHH-210	Remote Phone		HH		D03	Activated by APD
FALL-210	Remote Phone			LL	D03	Activated by APD
FSHH-211	WW-2032-10"-N	Detection of Any Flow	HH		D03	
FAHH-211	Remote Phone	Detection of Any Flow	HH		D03	Activated by APD
FSHH-213	WW-2035-10"-N	Detection of Any Flow	HH		D04	
FAHH-213	Remote Phone	Detection of Any Flow	HH		D04	Activated by APD

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 7 OF 12

LEVEL INSTRUMENTS

AREA NO. 20

TAG NO.	LOCATION	FLUID	S.G. @ °T	PRESSURE PSI A	TEMPERATURE °F		FOR INTERFACE SERVICE ONLY		VESSEL COVERAGE	HEIGHT ABOVE B.T.L./BOTTOM TO MAXIMUM LEVEL READING	SPECIAL MATERIALS	P&ID NO.	REMARKS
					NORMAL	MAXIMUM	FLUID #2	SG @ °T					
LI-304	Sump	Rain or Storm Water	1.0 @ 0	14.7	55	300	N/A	N/A	1½' to 7½'	13'	Teflon Coated	D01	WITH LE 304 & LT-304
LIC-306	T-2003	Treated Water	1.0 @ 0	14.7	55	300	N/A	N/A	1½' to 7½'	13'	Teflon Coated	D04	WITH LE-306 & LT-306

INSTRUMENT DATA
SUMMARY SHEET

LEVEL CONTROL VALVES

AREA NO. 20

FLUID CODE	FLUID UNITS
L = LIQUID	gpm
S = STEAM	/HR.
G = GAS V = VAPOR	S __ ^{3}/Hr. @ __ °__ At 1 Atmosphere

VALVE FAILURE CODE
O = OPEN S = CLOSED L = LOCK UP

PROJECT: 199814
DATE: 2/20/91
BY: Kovalcson
SHEET 6 OF 12

TAG NO.	LINE SIZE & NUMBER		FLOW RATES			PRESSURE PSI G			TEMP. ° F	SG OR (MW)	% FL'SH OR PSUPHT	MW FL'SH VAP		SPECIAL MATERIALS	P&ID NO.	REMARKS
			NORMAL	MAXIMUM	START-UP OR UPSET	UP-STREAM	DOWN-STREAM	MAXIMUM								
LV-306	WW-2037-10"-N	L	600	1600	50		31	50	55	1.0	0	—	L	N	D04	WITH LIC-306

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 9 OF 12

LEVEL RECEIVER ALARMS/SWITCHES

AREA NO. 20

TAG NO.	LOCATION	ACTUATION POINT	TYPE		P&ID NO.	REMARKS
			HIGH	LOW		
LSHL-301	Extraction Well #1		H	L	D01	Selector switch; w/LE-301
LSHL-302	Extraction Well #2		H	L	D01	Selector switch; w/LE-302
LSHL-303	Extraction Well #3		H	L	D01	Selector switch; w/LE-303
LAHH-304	Remote Panel		HH		D01	Activated by APD
LSHH-305	T-2003		HH		D04	Selector switch; w/LE-305
LAHH-305A	Local Panel	9' From Bottom of Tank	HH		D04	
LAHH-305B	Remote Phone	9' From Bottom of Tank	HH		D04	Activated by APD

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 2/18/91
BY: Kovalcson
SHEET 10 OF 12

TEMPERATURE INSTRUMENTS

AREA NO. 20

TAG NO.	LOCATION	FLUID	TEMPERATURE ° F		PRESSURE PSI G		THERMOWELL	P&ID NO.	REMARKS
			NORMAL	MAXIMUM	NORMAL	MAXIMUM	SPECIAL MATERIALS		
TI-401	T-2001	Process Water	55	180	4	125	N	D02	
TI-402	EC-2056-10"-Q	Vent Air	Ambient	180	0	125	Q	D02	
TI-403	T-2002	Process Water	55	180	4	125	N	D03	
TI-404	EC-2058-10"-Q	Vent Air	Ambient	180	0	125	Q	D03	
TI-405	WW-2037-10"-N	Effluent Water	55	180	31	125	N	D04	
TI-406	EC-2022-12"-W	Vent Air	Ambient	195	0	50	W	D05	
TI-407	EC-2044-12"-W	Vent Air	Ambient	195	0	50	W	D05	
TI-408	EC-2054-12"-W	Vent Air	Ambient	195	0	50	W	D05	

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 11 OF 12

MISCELLANEOUS RECEIVER ALARMS/SWITCHES

AREA NO. 20

TAG NO.	LOCATION	ACTUATION POINT	TYPE		P&ID NO.	REMARKS
			HIGH	LOW		
HS-501A	P-2001-Well #1	PB2L Selector Switch			D01	
HS-501B	Local Display				D01	With emergency stop and light
HS-502A	P-2004-Well #2	PB2L Selector Switch			D01	
HS-502B	Local Display				D01	With emergency stop and light
HS-503A	P-2005-Well #3	PB2L Selector Switch			D01	
HS-503B	Local Display				D01	With emergency stop and light
HS-504	B-2001A	PB2L Selector Switch			D02	
HS-505	B-2001B	PB2L Selector Switch			D02	
HS-506	B-2001C	PB2L Selector Switch			D02	
HS-507	B-2002A	PB2L Selector Switch			D03	
HS-508	B-2002B	PB2L Selector Switch			D03	
HS-509	B-2002C	PB2L Selector Switch			D03	
HS-510A	P-2002 Sump	PB2L Selector Switch			D01	
HS-510B	Local Display				D01	With emergency stop and light

INSTRUMENT DATA
SUMMARY SHEET

PROJECT: 199814
DATE: 3/20/91
BY: Kovalcson
SHEET 12 OF 12

MISCELLANEOUS RECEIVER ALARMS/SWITCHES

AREA NO. 20

TAG NO.	LOCATION	ACTUATION POINT	TYPE		P&ID NO.	REMARKS
			HIGH	LOW		
HS-511	P-2003A	PB2L Selector Switch			D04	
HS-512	P-2003B	PB2L Selector Switch			D04	
HS-513	B-2003A VS Motor	PB2L Selector Switch			D05	
HS-514	B-2003B VS Motor	PB2L Selector Switch			D05	
HS-515A	Local Display	Selector Switch			D01	Manual emergency stop and light
HS-515B	Remote via APD	Selector Switch			D01	Manual emergency stop and light activated by using APD

8.0 CONTROL DESCRIPTION

The three control systems (loops) for the GWTS are:

- Level control in the extraction well(s) for manipulating the amount of water withdrawn from the aquifer by the pumps
- Level control in the treatment system tankage to allow for variations in the flow rate
- Pressure control of Stages 1 and 2 of the aeration tanks to maintain a uniform atmospheric pressure in all aeration stages.

These control loops are described below.

8.1 LEVEL CONTROL IN WELLS

The extraction well(s) pumps will be controlled with a control loop consisting of a two-pronged conductance level probe element (LE), a level transmitter (LT), and a level switch high-low (LSHL). The probes in the wells will be set at different levels above the pump intake representing both high and low levels. The pump will not operate until the high probe senses water. The level switch will start the pump motor. The pump will remain on until the lower level probe no longer senses water. At this point, the level switch will stop the pump motor. The flow rate of the pump will be manually set during the observation period so that the level in the well will normally remain within the upper and lower level probes and the pump will be on most of the time. The pump operating cycle will vary due to increased or decreased water levels in the aquifer due to rainfall, drought, etc.

8.2 LEVEL CONTROL IN THE TREATMENT SYSTEM TANKS

The level in all three tanks (the primary and secondary aeration tanks and the degas tank) is essentially the same because the tanks are directly hydraulically connected with no pumps or other flow restrictions between the tanks. Therefore, controlling the level in one tank controls the level in all tanks. The tank that will contain the level controls is the Degas Tank (T-2003) because its level is expected to be more stable than the aeration tanks' levels. The Degas Tank level control loop will consist of a conductance level probe element (LE), a level transmitter (LT), a level indicating controller (LIC), and a level control valve (LV). The levels in the three tanks are affected by the amount of water coming in (from the wells) and the amount of water leaving the system (to the river). The extraction well pumps will determine the amount of water entering the system. The level control valve is located on the treated water discharge line. This control loop will determine the amount of water leaving the system by opening or closing the level control valve in increments to keep the level in the entire system constant. In other words, if the level rises, the level valve will open more to allow more flow out of the system, thereby lowering the level

In the system. The valve position changes proportionately in response to the level deviation from the set point. The level control loop also has provisions for level conditions outside the operation range. A high level condition will turn on the second Discharge Pump (P-2003), and a low level condition will shut off the second discharge pump if it is on. The high and low level conditions will alarm locally. The high-high condition will shut down the entire extraction well and treatment system to prevent overflow, and the low-low condition will shut off all discharge pumps (P-2003A,B) to protect them. High-high and low-low conditions will alarm locally and remotely.

8.3 PRESSURE CONTROL OF THE AERATION TANKS

If, for some reason, the air flow to the Aeration Tanks (T-2001, T-2002) was reduced, the Exhaust Blowers (B-2003A,B), if not controlled, could attempt to pull too much air, resulting in negative pressure in the aeration tanks. Likewise, if the exhaust blowers could not adapt to increases in air flow to the aeration tanks, the tanks could pressurize slightly. To avoid these situations, the exhaust blowers have variable speed motors that will control the amount of air pulled from the primary aeration tank and discharge to the carbon system. The blower speed and the pressure in the aeration tanks will be controlled with a control loop consisting of a pressure indicating controller (PIC), a selector switch (PY), and pressure transmitters (PT) that are normally connected to the first two stages of the primary aeration tank. The output from the pressure transmitters will be averaged. If the primary aeration tank is not being used, a selector switch (PY) will be used to select the pressure signal from the secondary aeration tank to serve as the input to the control loop. The PIC will adjust the speed of the exhaust blower that is on-line to maintain a constant (atmospheric) pressure in the first two aeration stages. The other aeration stages will remain at atmospheric pressure because they are vented directly to the atmosphere.

9.0 LOGIC DIAGRAM

Logic diagrams supplement information on the PFD's and P&ID's for the automated shutdown systems (interlocks) in sufficient detail for instrumentation and electrical design. Because the control loops in this system are relatively simple, logic diagrams are not necessary. The information contained on the P&IDs is adequate to convey the pertinent details of the process design. Logic diagrams will be completed as a portion of the detailed design stage of this project.

10.0 DRAWING LIST

The drawing list provides an itemized listing of all drawings related to the GWTS. Drawings include PFD, P&IDs, Site Layout, Equipment Arrangement, Elevation View and Electrical One-Line Diagram. The first four sheets in the drawing set (lead sheets) contain information pertinent to understanding the nomenclature and symbols on the drawings. These sheets are standard for all projects, therefore, some of the information may not be relevant to this project.

10.1 DRAWING NUMBERS

The following numbering system was used during the process design of the project and will continue to be used during the detail design of the project. All drawing numbers are assigned by the drafting department of the designing facility.

Example Drawing Number: 172501 - 20 - D01

- 172501 — Project No.
- 20 — Area No.
- D01 — Drawing letter-type
- 01 — Sequence number

The area number is always a two-digit number. Area numbers are an IT standard used to distinguish various processes. Because this GWTS is small, only one area number is used (20). Other area numbers may be added later if additional processes are added. Area numbers below 20 are used for utility systems. Drawing letters are determined from the list below. The sequence number is always a two-digit number. The first drawing done within each drawing letter within an area shall have the number 01.

Drawing Letter	Type of Drawing
A	Architectural
C	Civil
D	Piping and instrument diagram
E	Electrical
F	Process flow diagram (includes block flow)
G	General arrangement
H	Heating Ventilating and Air Conditioning (HVAC)

Drawing Letter	Type of Drawing
I	Instrumentation
K	Geotech
L	Process logic drawing
M	Mechanical
P	Piping
S	Site
T	Structural
U	Utility piping and instrument diagram
X	Miscellaneous

10.2 VENDOR DRAWING NUMBERS

A numbering system must be implemented for document control within IT for the times when non-IT drawings are generated by vendors during process and detailed design. This system consists of a unique sequential number assigned to the drawing. (These drawing numbers are included with the IT generated drawings for completeness of the drawing list.)

The following numbering system will be used during the process design and detail design for non-IT generated drawings.

Example Drawing Number: 101725 - 50 - MP - E01 - 01

- Project number
- Area number
- Vendor identifier
- Drawing letter
- Sequence number
- Revision

The project number, area number, drawing letter, and sequence number are identical to those described in Section 10.1 for IT generated drawings. The vendor identifier is representative of the vendor company name. A list of vendor identifiers should be developed at the start of the project for consistent use throughout. Identifiers should be limited to two or three alphabetic characters. At this time, no vendor drawings are included in the process design manual.

TABLE 10-1. DRAWING LIST

DWG NO.	DESCRIPTION	START		REV A		REV B		REV 0		REV		ACTUAL DATES						% COMPLETE/REMARKS
		SCH.	ACT.	SCH.	ACT.	SCH.	ACT.	SCH.	ACT.	SCH.	ACT.	REVISION						
		F/C		F/C		F/C		F/C		F/C		A	B	C	0	1	2	
199814-00-D01	LEAD SHEET - INSTRUMENT IDENTIFICATION	2/4/91	2/18/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-00-D02	LEAD SHEET - CONTROL SYSTEM STANDARDS	2/4/91	2/18/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-00-D03	LEAD SHEET - CONTROL LOOP STANDARDS	2/4/91	2/18/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-00-D04	LEAD SHEET - PIPING & EQUIPMENT IDENTIFICATION	2/4/91	2/18/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-F01	PFD - GROUND WATER TREATMENT SYSTEM	2/4/91	2/4/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-D01	P&ID - EXTRACTION WELLS AND SUMP	2/4/91	2/4/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-D02	P&ID - PRIMARY AERATION TANK	2/4/91	2/4/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-D03	P&ID -SECONDARY AERATION TANK	2/4/91	2/4/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-D04	P&ID - DEGASIFICATION AND DISCHARGE	2/4/91	2/4/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-D05	P&ID - EMISSION CONTROL SYSTEM AND VENT	2/4/91	2/4/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-C01	SITE LAYOUT	2/4/91	2/8/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-C02	EQUIPMENT ARRANGEMENT	2/4/91	2/8/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			
199814-20-G01	WEST ELEVATION VIEW	2/15/91	2/15/91	2/21/91	2/21/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			

REV	DESCRIPTION	DATE	BY
A	Issued for Draft Process Design	2/22/91	TSK
B	Issued for Client and Regulatory Review	3/20/91	JAB
0	Issued as Final Process Design	5/9/91	JAB

COMPANY NAME: Wright-Patterson Air Force Base

PROJECT NAME: Ground Water Treatment System

PROJECT NO. 199814

CHARGE NO. .05.03.01

AREA NAME: GWTS

AREA NO. 20

LOCATION: WPAFB, Ohio

BY: Kovalcson

CHECKED: Becker

APP'D: Helsel

DATE: 01/31/92

TABLE 10-1. DRAWING LIST

DWG NO.	DESCRIPTION	START SCH. F/C	START ACT.	REV A SCH. F/C	REV A ACT.	REV B SCH. F/C	REV B ACT.	REV 0 SCH. F/C	REV 0 ACT.	REV ___ SCH. F/C	REV ___ ACT.	ACTUAL DATES REVISION A	B	C	0	1	2	% COMPLETE/REMARKS
199814-20-E01	ELECTRICAL ONE-LINE DIAGRAM	2/4/91	2/12/91	2/22/91	2/22/91	3/19/91	3/20/91	5/9/91	5/9/91			2/22/91	3/20/91		5/9/91			

REV	DESCRIPTION	DATE	BY
A	Issued for Draft Process Design	02/22/91	TSK
B	Issued for Client and Regulatory Review	3/20/91	JAB
0	Issued as Final Process Design	5/9/91	JAB

COMPANY NAME: Wright-Patterson Air Force Base

PROJECT NAME: Ground Water Treatment System

PROJECT NO. 199814

CHARGE NO. .05.03.01

AREA NAME: GWTS

AREA NO. 20

LOCATION: WPAFB, Ohio

BY: Kc valcson

CHECKED: Becker

APPD: Heisel

DATE: 01/31/92

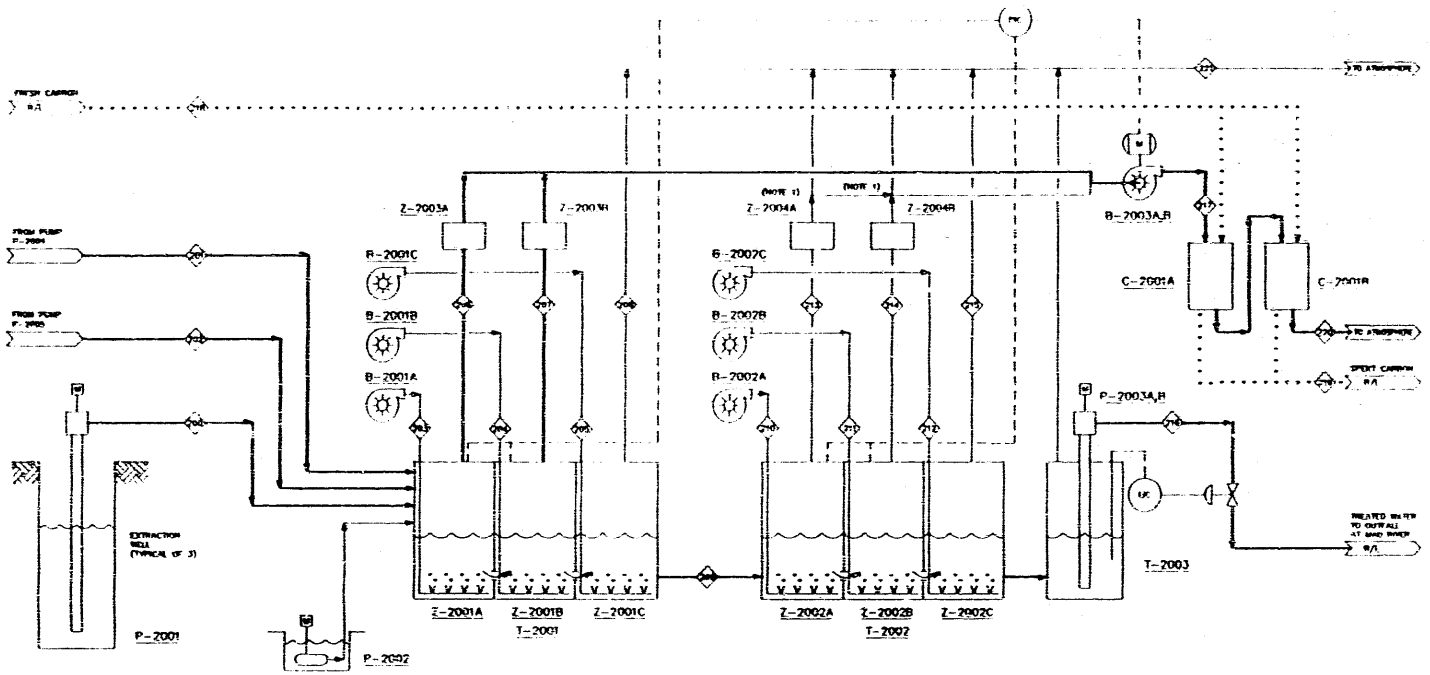
11.0 PROCESS FLOW DIAGRAMS (PFDs)

The function of the PFD is to provide, in pictorial form, the documentation of process information. Because it is a simplified description of process flows and equipment, the PFD is a useful tool for understanding the project goals and is a foundation for further process engineering.

The Material Balance documents quantative material flows, stream components, and processing conditions.

The PFD shows all named and numbered equipment except for ex-battery limits utilities. Where practical, equipment is shown in relative shape, size, and elevation as in the intended final facility. Installed spare equipment items may be indicated by a single equipment symbol and identified by multiple equipment numbers and names. Process flow streams are shown and numbered to tie into the Material Balance.

Instrumentation other than Principal Control Schemes is not shown on the formal PFD.



P-2001	P-2004	P-2005	P-2002	B-2001A–C	Z-2001A–C	T-2001	Z-2003A,B	B-2002A–C	Z-2002A–C	T-2002	Z-2004A,B	B-2003A,B	C-2001A,B	T-2003	P-2003A,B
EXTRACTION WELL PUMP (3	EXTRACTION WELL PUMP (2	EXTRACTION WELL PUMP (2)	SECONDARY CONTAINMENT SUMP PUMP	PRIMARY AERATION BLOWER	PRIMARY DIFFUSER	PRIMARY AERATION TANK (STAGES 1–3)	PRIMARY DEMISTER	SECONDARY AERATION BLOWER	SECONDARY DIFFUSER	SECONDARY AERATION TANK (STAGES 4–6)	SECONDARY DEMISTER	EXHAUST BLOWER	VAPOR-PHASE CARBON ADSORBER	DEGAS TANK	TREATED WATER DISCHARGE PUMP

STREAM NO																								
COMPONENT																								
TOTAL	(lb/hr)																							
TOTAL	(lb/day)																							
TOTAL	(gpm)																							
TOTAL	(scfm)																							
TOTAL AIR	(cu ft/hr)																							
DENSITY	(lb/cu ft)																							
DENSITY	(lb/gal)	8.34	8.34	8.34	8.34																			

DESIGN BASIS			
YEARLY CAPACITY			
DAILY CAPACITY			
OPERATING DAYS/YR			
OPERATING HRS/DAY			

GENERAL NOTES

1. AIR FLOW FROM TANKS T-2002 VIA LINES 213 AND 214 WILL NORMALLY BE PIPED TO VENT TO THE ATMOSPHERE. THE ALTERNATIVE ROUTE THROUGH THE VAPOR PHASE CARBON ADSORBERS C-2001A, B WILL BE USED WHEN TANK T-2001 IS OUT OF SERVICE FOR MAINTENANCE REASONS.
2. WATER IN SPENT CARBON IS BASED ON ONE POUND OF WATER PER POUND OF CARBON.
3. ANY STREAM COMPONENT HAVING LESS THAN 0.001 LB/HR IS NOT SHOWN IN MATERIAL BALANCE.
4. THIS MATERIAL BALANCE REPRESENTS THE MAXIMUM DESIGN CONDITION OF 800 GPM TOTAL FLOW. THE NORMAL DESIGN IS 600 GPM.
5. CIS-DICHLOROETHYLENE IS SHOWN IN THE MATERIAL BALANCE TO REPRESENT ALL OTHER VOLATILE CHLORINATED HYDROCARBONS. IT WAS CHOSEN BECAUSE IT IS THE MOST DIFFICULT TO AIR STRIP.

NO	DATE	REVISION	BY	CHK	APP
0	1/30/91	FINAL PROCESS REVIEW			
0	1/30/91	AGENCY & REGULATORY REVIEW			
A	8/13/90	DRAFT PROCESS REVIEW			

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAM

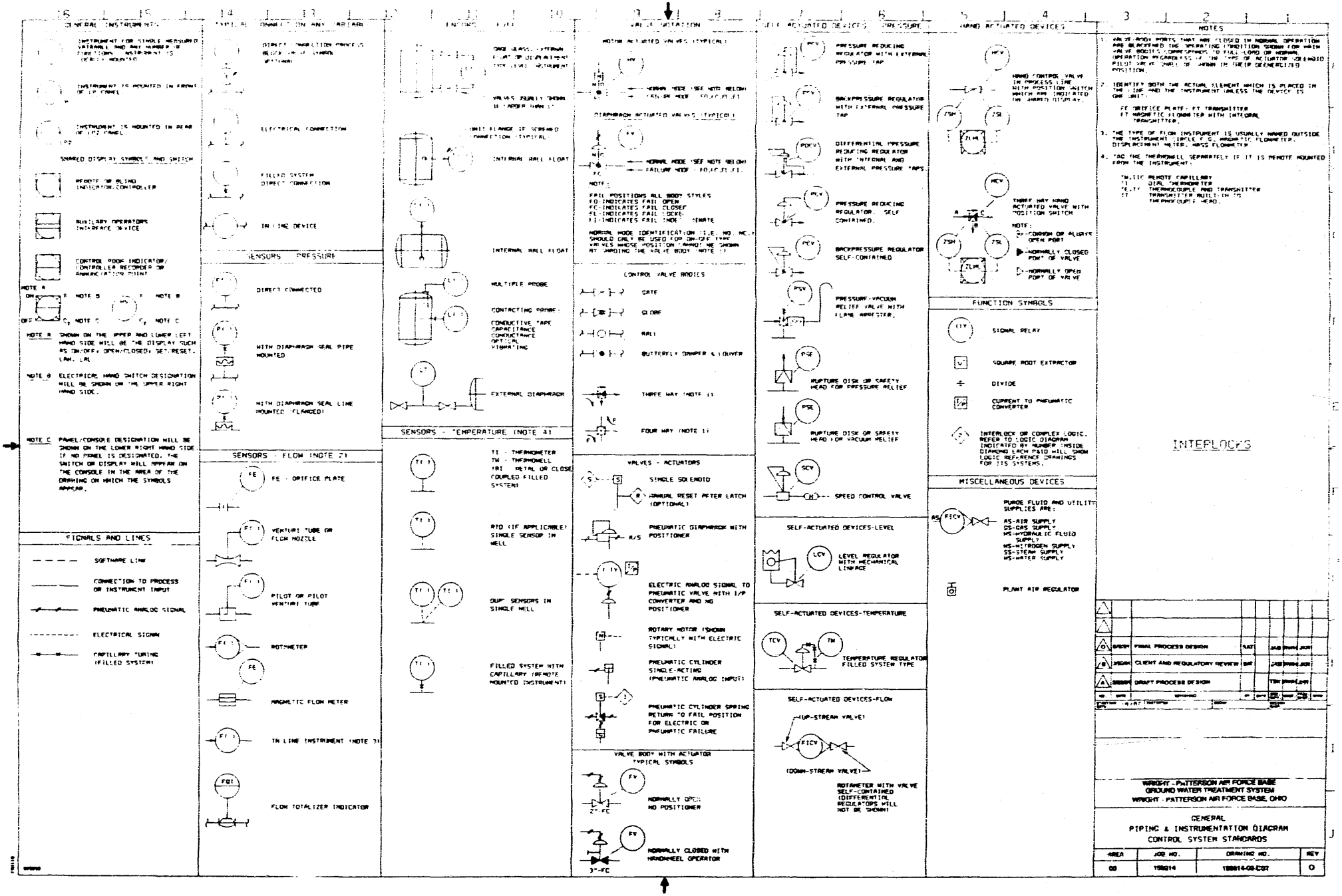
AREA	JOB NO	DRAWING NO	REV
20	199814	199814-20-F01	0

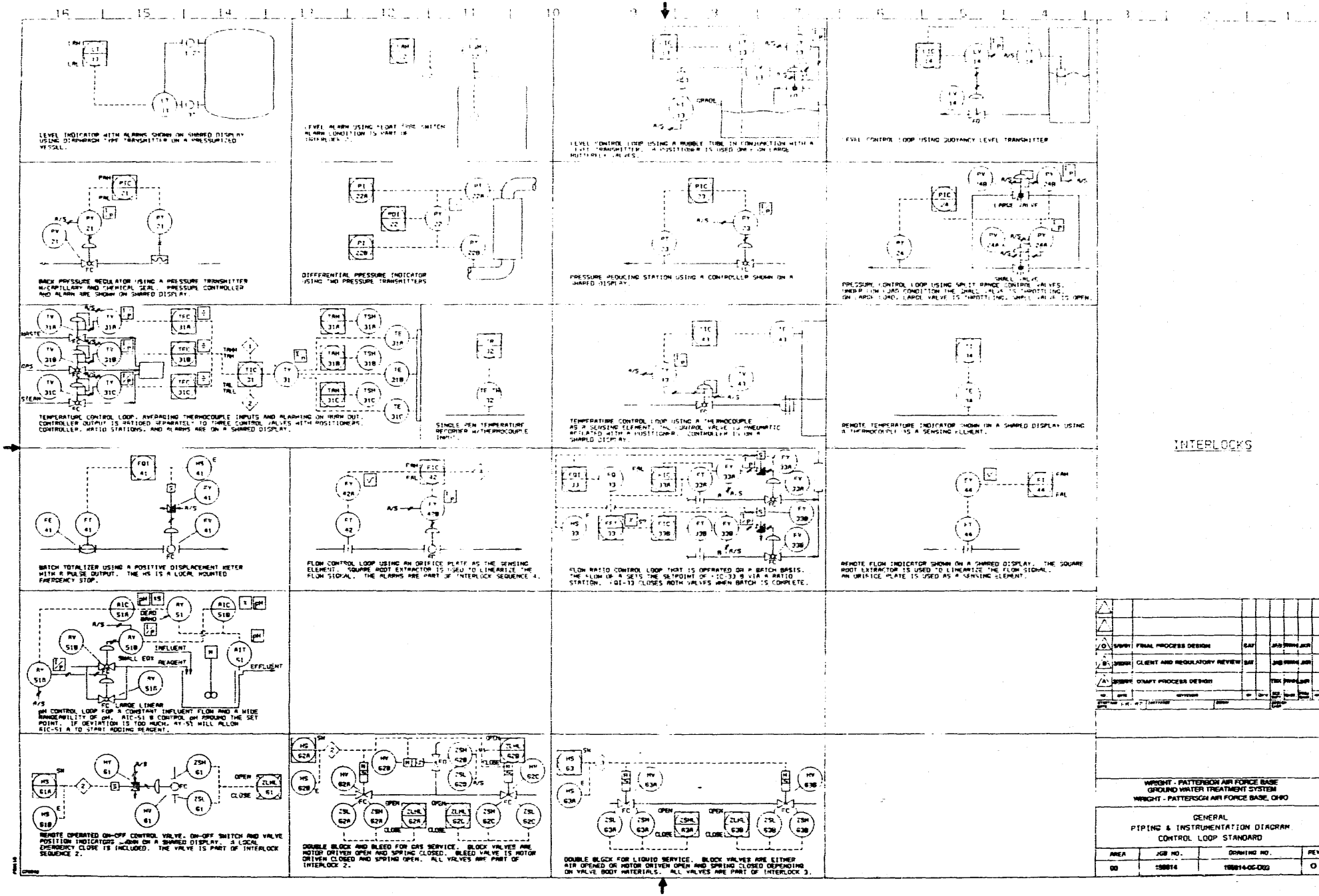
12.0 PIPING AND INSTRUMENT DRAWINGS (P&IDs)

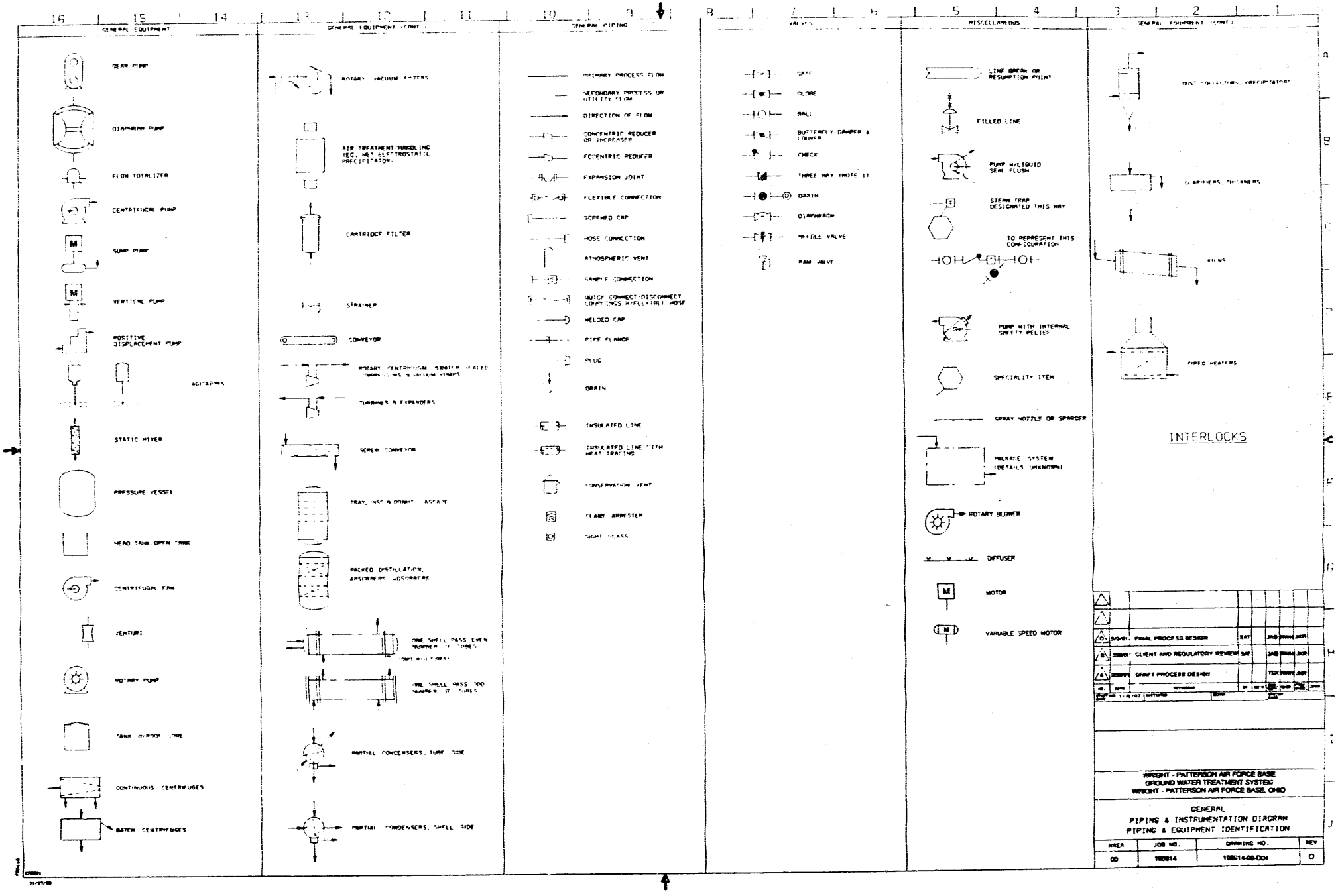
The P&ID is a detailed diagrammatic representation of all equipment, piping, and instrumentation required for a processing system or portion thereof. As such, the P&ID accomplishes many purposes, including:

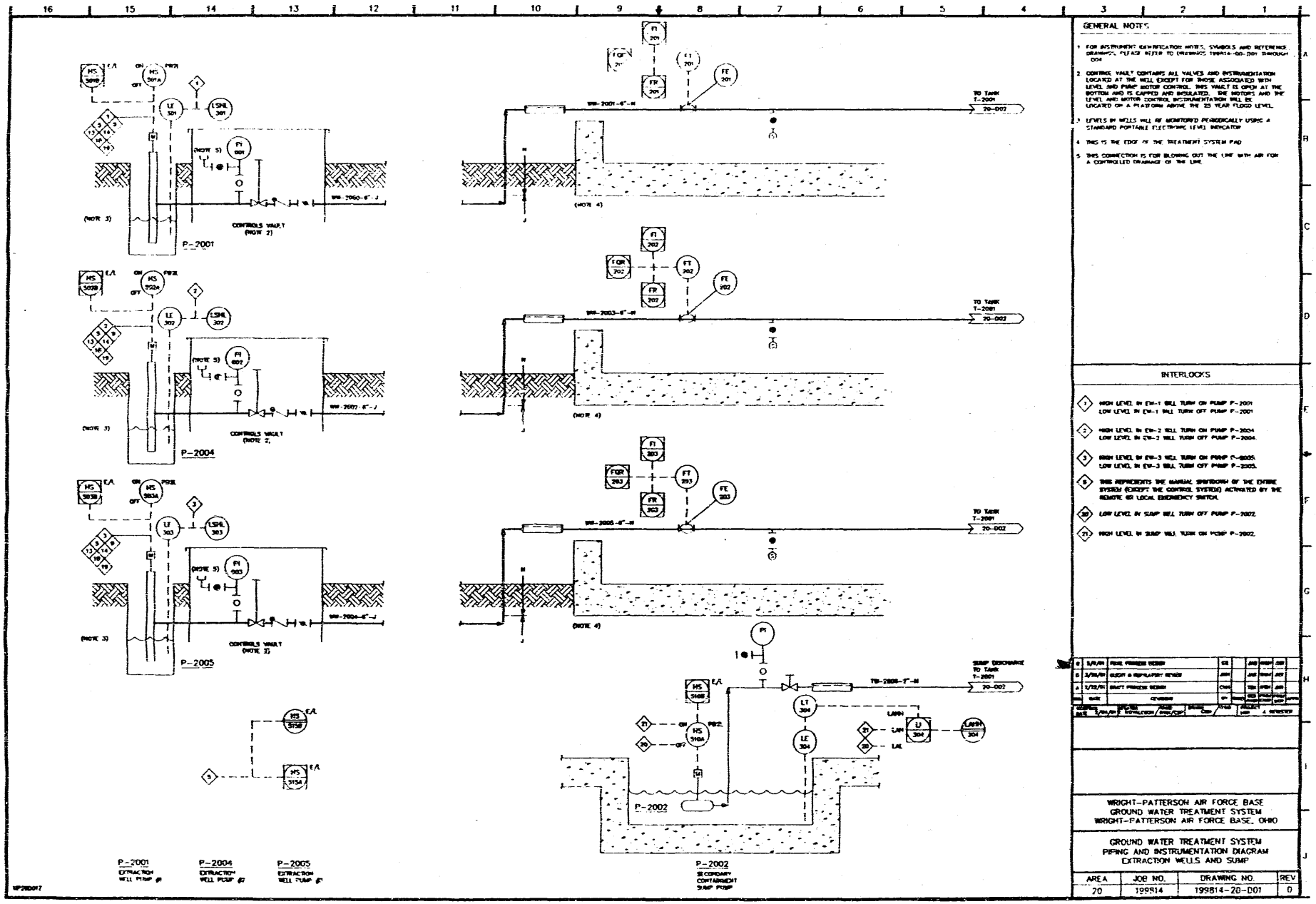
- Provides much of the information needed to start detailed design and procurement of piping and controls
- Conveys to operating and construction personnel the piping and instrumentation design concepts being developed on the project
- Serves as the summary document for detailed piping drawings during field installation of piping and controls
- Provides the beginning basis for writing operation and maintenance manuals.

Lead sheets are furnished to describe the nomenclature used for this process design. This nomenclature should be continued throughout the remainder of the project including the detailed design.


GENERAL INSTRUMENTS
SIGNALS AND LINES
SOFTWARE LINK
CONNECTION TO PROCESS OR INSTRUMENT INPUT
PNEUMATIC ANALOG SIGNAL
ELECTRICAL SIGNAL
CAPILLARY TUBING (FILLED SYSTEM)
TYPICAL CONNECTION ARRANGEMENTS
DIRECT CONNECTION PROCESS MEDIA (FLUID, GAS, STEAM)
ELECTRICAL CONNECTION
FILLED SYSTEM DIRECT CONNECTION
IN LINE DEVICE
SENSORS - PRESSURE
DIRECT CONNECTED
WITH DIAPHRAGM SEAL PIPE MOUNTED
WITH DIAPHRAGM SEAL LINE MOUNTED (FLANGED)
SENSORS - FLOW (NOTE 2)
FE - ORIFICE PLATE
VENTURI TUBE OR FLOW NOZZLE
PILOT OR PILOT VENTURI TUBE
ROTAMETER
MAGNETIC FLOW METER
IN LINE INSTRUMENT (NOTE 3)
FLOW TOTALIZER INDICATOR
SENSORS - LEVEL
ONE GLASS, EXTERNAL FLOAT OR DISPLACEMENT TYPE LEVEL INSTRUMENT
VALVES EQUALLY SPACED IF MORE THAN 1
UNIT FLANGE IF SCREWED CONNECTION (TYPICAL)
INTERNAL BALL FLOAT
INTERNAL RAIL FLOAT
MULTIPLE PROBE
CONTACTING PROBE:
CONDUCTIVE TAPE
CAPACITANCE
CONDUCTANCE
OPTICAL
VIBRATING
EXTERNAL DIAPHRAGM
SENSORS - TEMPERATURE (NOTE 4)
TI - THERMOMETER
TW - THERMOWELL
TBE - METAL OR CLOSE COUPLED FILLED SYSTEM
RTD (IF APPLICABLE) SINGLE SENSOR IN WELL
DUAL SENSORS IN SINGLE WELL
FILLED SYSTEM WITH CAPILLARY (REMOTE MOUNTED INSTRUMENT)
VALVE OPERATION
MOTOR ACTUATED VALVES (TYPICAL)
NORMAL MODE (SEE NOTE BELOW)
FAILURE MODE - FO/FC/FL/FI
DIAPHRAGM ACTUATED VALVES (TYPICAL)
NOTE:
FAIL POSITIONS ALL BODY STYLES
FO: INDICATES FAIL OPEN
FC: INDICATES FAIL CLOSED
FL: INDICATES FAIL LOCK
FI: INDICATES FAIL INDETERMINATE
NORMAL MODE IDENTIFICATION (I.E. NO NC, NO) SHOULD ONLY BE USED FOR ON-OFF TYPE VALVES WHOSE POSITION (NORMAL) ARE SHOWN AT PARTING THE VALVE BODY. NOTE 1)
CONTROL VALVE BODIES
GATE
GLOBE
BALL
BUTTERFLY DAMPER & LOUVER
THREE WAY (NOTE 1)
FOUR WAY (NOTE 1)
VALVES - ACTUATORS
SINGLE SOLENOID
MANUAL RESET PETER LATCH (OPTIONAL)
PNEUMATIC DIAPHRAGM WITH POSITIONER
ELECTRIC ANALOG SIGNAL TO PNEUMATIC VALVE WITH I/P CONVERTER AND NO POSITIONER
ROTARY MOTOR (SHOWN TYPICALLY WITH ELECTRIC SIGNAL)
PNEUMATIC CYLINDER SINGLE-ACTING (PNEUMATIC ANALOG INPUT)
PNEUMATIC CYLINDER SPRING RETURN TO FAIL POSITION FOR ELECTRIC OR PNEUMATIC FAILURE
VALVE BODY WITH ACTUATOR TYPICAL SYMBOLS
NORMALLY OPEN NO POSITIONER
NORMALLY CLOSED WITH HANDWHEEL OPERATOR
SELF ACTUATED DEVICES - PRESSURE
PRESSURE REDUCING REGULATOR WITH EXTERNAL PRESSURE TAP
BACKPRESSURE REGULATOR WITH EXTERNAL PRESSURE TAP
DIFFERENTIAL PRESSURE REDUCING REGULATOR WITH INTERNAL AND EXTERNAL PRESSURE TAPS
PRESSURE REDUCING REGULATOR, SELF CONTAINED
BACKPRESSURE REGULATOR SELF-CONTAINED
PRESSURE-VACUUM RELIEF VALVE WITH FLAME ARRESTER.
RUPTURE DISK OR SAFETY HEAD FOR PRESSURE RELIEF
RUPTURE DISK OR SAFETY HEAD FOR VACUUM RELIEF
SPEED CONTROL VALVE
SELF-ACTUATED DEVICES-LEVEL
LEVEL REGULATOR WITH MECHANICAL LINKAGE
SELF-ACTUATED DEVICES-TEMPERATURE
TEMPERATURE REGULATOR FILLED SYSTEM TYPE
SELF-ACTUATED DEVICES-FLOW
(UP-STREAM VALVE)
(DOWN-STREAM VALVE)
ROTAMETER WITH VALVE SELF-CONTAINED (DIFFERENTIAL REGULATORS WILL NOT BE SHOWN)
HAND ACTUATED DEVICES
HAND CONTROL VALVE IN PROCESS LINE WITH POSITION SWITCH WHICH ARE INDICATED ON SHARED DISPLAY.
THREE WAY HAND ACTUATED VALVE WITH POSITION SWITCH
NOTE:
C - COMMON OR ALWAYS OPEN PORT
NORMALLY CLOSED PORT OF VALVE
NORMALLY OPEN PORT OF VALVE
FUNCTION SYMBOLS
SIGNAL RELAY
SQUARE ROOT EXTRACTOR
DIVIDE
CURRENT TO PNEUMATIC CONVERTER
INTERLOCK OR COMPLEX LOGIC. REFER TO LOGIC DIAGRAM INDICATED BY NUMBER INSIDE DIAMOND. EACH P&ID WILL SHOW LOGIC REFERENCE DRAWINGS FOR ITS SYSTEMS.
MISCELLANEOUS DEVICES
PURGE FLUID AND UTILITY SUPPLIES ARE:
AS-AIR SUPPLY
GS-GAS SUPPLY
HS-HYDRAULIC FLUID SUPPLY
NS-NITROGEN SUPPLY
SS-STEAM SUPPLY
WS-WATER SUPPLY
PLANT AIR REGULATOR
NOTES
1. VALVE BODY PARTS THAT ARE CLOSED IN NORMAL OPERATION ARE REFERRED TO "OPERATING CONDITION SHOWN FOR MAIN VALVE BODY". COMPONENTS TO FAIL LOAD OR NORMAL OPERATION REGARDLESS OF THE TYPE OF ACTUATOR (SOLENOID PILOT VALVE SHALL BE SHOWN IN THEIR DE-ENERGIZED POSITION.
2. IDENTIFY BOTH THE ACTUAL ELEMENT WHICH IS PLACED IN THE LINE AND THE INSTRUMENT (UNLESS THE DEVICE IS ONE UNIT).
FE ORIFICE PLATE; FT TRANSMITTER
FT MAGNETIC FLOWMETER WITH INTEGRAL TRANSMITTER.
3. THE TYPE OF FLOW INSTRUMENT IS USUALLY NAMED OUTSIDE THE INSTRUMENT CIRCLE (I.E. MAGNETIC FLOWMETER, DISPLACEMENT METER, MASS FLOWMETER).
4. TAG THE THERMOWELL SEPARATELY IF IT IS REMOTE MOUNTED FROM THE INSTRUMENT.
FM-FILLED REMOTE CAPILLARY
TI DIAL THERMOMETER
TE,TY THERMOCOUPLE AND TRANSMITTER
TT TRANSMITTER BUILT-IN TO THERMOCOUPLE HEAD.
INTERLOCKS
WRIGHT - PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT - PATTERSON AIR FORCE BASE, OHIO
GENERAL
PIPING & INSTRUMENTATION DIAGRAM
CONTROL SYSTEM STANDARDS
AREA 00
JOB NO. 198614
DRAWING NO. 198614-00-C02
REV 0


LEVEL INDICATOR WITH ALARMS SHOWN ON SHARED DISPLAY USING DIAPHRAGM TYPE TRANSMITTER ON A PRESSURIZED VESSEL.
LEVEL ALARM USING FLOAT TYPE SWITCH
LEVEL CONTROL LOOP USING A BUBBLE TUBE IN CONJUNCTION WITH A DP TRANSMITTER. A POSITIONER IS USED ON A LARGE BUTTERFLY VALVES.
LEVEL CONTROL LOOP USING BUOYANCY LEVEL TRANSMITTER
BACK PRESSURE REGULATOR USING A PRESSURE TRANSMITTER W/CAPILLARY AND CHEMICAL SEAL. PRESSURE CONTROLLER AND ALARMS ARE SHOWN ON SHARED DISPLAY.
DIFFERENTIAL PRESSURE INDICATOR USING TWO PRESSURE TRANSMITTERS
PRESSURE REDUCING STATION USING A CONTROLLER SHOWN ON A SHARED DISPLAY.
PRESSURE CONTROL LOOP USING SPLIT RANGE CONTROL VALVES. WHEN FLOW IS AT CONDITION THE SMALL VALVE IS THROTTLING. ON LARGE LOAD, LARGE VALVE IS THROTTLING, SMALL VALVE IS OPEN.
WASTE
GAS
STEAM
TEMPERATURE CONTROL LOOP. AVERAGING THERMOCOUPLE INPUTS AND ALARMING ON MAIN OUT. CONTROLLER OUTPUT IS RELIED SEPARATELY TO THREE CONTROL VALVES WITH POSITIONERS. CONTROLLER, RATIO STATIONS, AND ALARMS ARE ON A SHARED DISPLAY.
SINGLE PEN TEMPERATURE RECORDER W/THERMOCOUPLE INPUT
TEMPERATURE CONTROL LOOP USING A THERMOCOUPLE AS A SENSING ELEMENT. THE CONTROL VALVE IS PNEUMATIC ACTUATED WITH A POSITIONER. CONTROLLER IS ON A SHARED DISPLAY.
REMOTE TEMPERATURE INDICATOR SHOWN ON A SHARED DISPLAY USING A THERMOCOUPLE AS A SENSING ELEMENT.
INTERLOCKS
BATCH TOTALIZER USING A POSITIVE DISPLACEMENT METER WITH A PULSE OUTPUT. THE HS IS A LOCAL MOUNTED EMERGENCY STOP.
FLOW CONTROL LOOP USING AN ORIFICE PLATE AS THE SENSING ELEMENT. SQUARE ROOT EXTRACTOR IS USED TO LINEARIZE THE FLOW SIGNAL. THE ALARMS ARE PART OF INTERLOCK SEQUENCE 4.
FLOW RATIO CONTROL LOOP THAT IS OPERATED ON A BATCH BASIS. THE FLOW OF A SETS THE SETPOINT OF FIC-33 B VIA A RATIO STATION. FQI-13 CLOSES BOTH VALVES WHEN BATCH IS COMPLETE.
REMOTE FLOW INDICATOR SHOWN ON A SHARED DISPLAY. THE SQUARE ROOT EXTRACTOR IS USED TO LINEARIZE THE FLOW SIGNAL. AN ORIFICE PLATE IS USED AS A SENSING ELEMENT.
pH CONTROL LOOP FOR A CONSTANT INFLUENT FLOW AND A WIDE RANGEABILITY OF pH. AIC-51 B CONTROL pH AROUND THE SET POINT. IF DEVIATION IS TOO MUCH, AY-51 WILL ALLOW AIC-51 A TO START ADDING REAGENT.
INFLUENT
REAGENT
EFFLUENT
SMALL EQT
LARGE LINEAR
REMOTE OPERATED ON-OFF CONTROL VALVE. ON-OFF SWITCH AND VALVE POSITION INDICATORS SHOWN ON A SHARED DISPLAY. A LOCAL EMERGENCY CLOSE IS INCLUDED. THE VALVE IS PART OF INTERLOCK SEQUENCE 2.
DOUBLE BLOCK AND BLEED FOR GAS SERVICE. BLOCK VALVES ARE MOTOR DRIVEN OPEN AND SPRING CLOSED. BLEED VALVE IS MOTOR DRIVEN CLOSED AND SPRING OPEN. ALL VALVES ARE PART OF INTERLOCK 2.
DOUBLE BLOCK FOR LIQUID SERVICE. BLOCK VALVES ARE EITHER AIR OPENED OR MOTOR DRIVEN OPEN AND SPRING CLOSED DEPENDING ON VALVE BODY MATERIALS. ALL VALVES ARE PART OF INTERLOCK 3.
0 FINAL PROCESS DESIGN
B CLIENT AND REGULATORY REVIEW
A DRAFT PROCESS DESIGN
WRIGHT - PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT - PATTERSON AIR FORCE BASE, OHIO
GENERAL
PIPING & INSTRUMENTATION DIAGRAM
CONTROL LOOP STANDARD
AREA
JOB NO.
DRAWING NO.
REV
00
198814
198814-05-003
0


GENERAL EQUIPMENT
GEAR PUMP
DIAPHRAM PUMP
FLOW TOTALIZER
CENTRIFUGAL PUMP
SUMP PUMP
VERTICAL PUMP
POSITIVE DISPLACEMENT PUMP
AGITATORS
STATIC MIXER
PRESSURE VESSEL
HEAD TANK, OPEN TANK
CENTRIFUGAL FAN
VENTURI
ROTARY PUMP
CONTINUOUS CENTRIFUGES
BATCH CENTRIFUGES
GENERAL EQUIPMENT (CONT.)
ROTARY VACUUM FILTERS
AIR TREATMENT (SCRUBBING (EG., WET ELECTROSTATIC PRECIPITATOR,
CARTRIDGE FILTER
STRAINER
CONVEYOR
TURBINES & EXPANDERS
SCREW CONVEYOR
PACKED DISTILLATION, ABSORBERS, ADSORBERS
ONE SHELL PASS EVEN NUMBER OF TUBES
ONE SHELL PASS 300 NUMBER OF TUBES
PARTIAL CONDENSERS, TUBE SIDE
PARTIAL CONDENSERS, SHELL SIDE
GENERAL PIPING
PRIMARY PROCESS FLOW
SECONDARY PROCESS OR UTILITY FLOW
DIRECTION OF FLOW
CONCENTRIC REDUCER OR INCREASER
ECCENTRIC REDUCER
EXPANSION JOINT
FLEXIBLE CONNECTION
SCREWED CAP
HOSE CONNECTION
ATMOSPHERIC VENT
SAMPLE CONNECTION
QUICK CONNECT-DISCONNECT COUPLINGS W/FLEXIBLE HOSE
WELDED CAP
PIPE FLANGE
PLUG
DRAIN
INSULATED LINE
INSULATED LINE WITH HEAT TRACING
EXPANSION JOINT
FLAME ARRESTER
SIGHT GLASS
VALVES
GATE
GLOBE
BALL
BUTTERFLY DAMPER & LOUVER
CHECK
THREE WAY (NOTE 1)
DRAIN
DIAPHRAGM
NEEDLE VALVE
RAM VALVE
MISCELLANEOUS
LINE BREAK OR RESUMPTION POINT
FILLED LINE
PUMP W/LIQUID SEAL FLUSH
STEAM TRAP DESIGNATED THIS WAY
TO REPRESENT THIS CONFIGURATION
PUMP WITH INTERNAL SAFETY RELIEF
SPECIALITY ITEM
SPRAY NOZZLE OR SPARGER
PACKAGE SYSTEM (DETAILS UNKNOWN)
ROTARY BLOWER
DIFFUSER
MOTOR
VARIABLE SPEED MOTOR
GENERAL EQUIPMENT (CONT.)
DUST COLLECTION, PRECIPITATOR
CLARIFIERS, THICKENERS
KILNS
FIRED HEATERS
INTERLOCKS
0 9/98 FINAL PROCESS DESIGN SAT JAB
A 2/98 DRAFT PROCESS DESIGN TSK JAB
WRIGHT - PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT - PATTERSON AIR FORCE BASE, OHIO
GENERAL
PIPING & INSTRUMENTATION DIAGRAM
PIPING & EQUIPMENT IDENTIFICATION
AREA JOB NO. DRAWING NO. REV
00 198814 198514-00-004 0



GENERAL NOTES

1. FOR INSTRUMENT IDENTIFICATION NOTES, SYMBOLS AND REFERENCE DRAWINGS, PLEASE REFER TO DRAWINGS 199814-00-D01 THROUGH D04
2. CONTROL VAULT CONTAINS ALL VALVES AND INSTRUMENTATION LOCATED AT THE WELL EXCEPT FOR THOSE ASSOCIATED WITH LEVEL AND PUMP MOTOR CONTROL. THIS VAULT IS OPEN AT THE BOTTOM AND IS CAPPED AND INSULATED. THE MOTORS AND THE LEVEL AND MOTOR CONTROL INSTRUMENTATION WILL BE LOCATED ON A PLATFORM ABOVE THE 25 YEAR FLOOD LEVEL.
3. LEVELS IN WELLS WILL BE MONITORED PERIODICALLY USING A STANDARD PORTABLE ELECTRONIC LEVEL INDICATOR
4. THIS IS THE EDGE OF THE TREATMENT SYSTEM PAD
5. THIS CONNECTION IS FOR BLOWING OUT THE LINE WITH AIR FOR A CONTROLLED DISCHARGE OF THE LINE.

INTERLOCKS

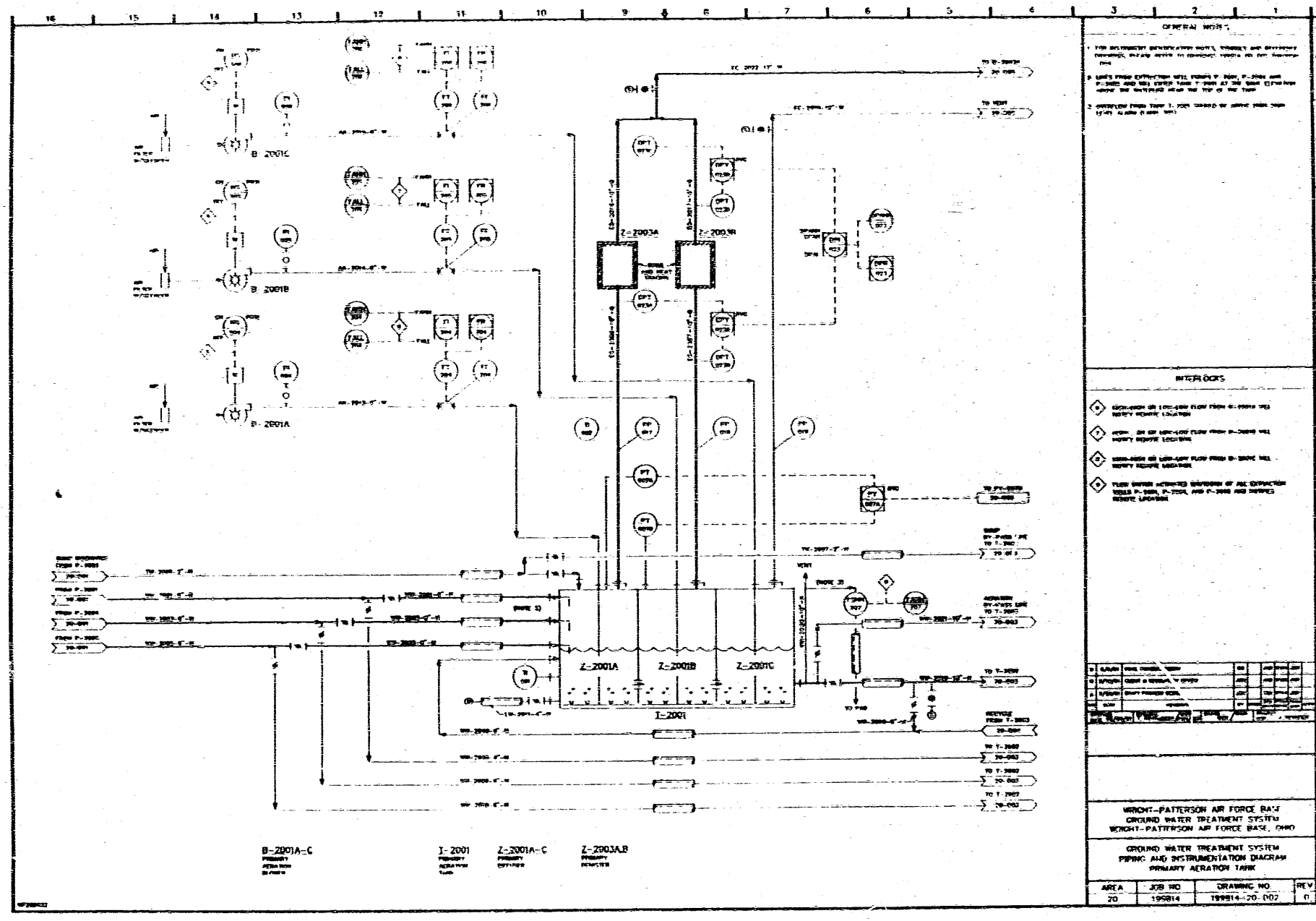
1. HIGH LEVEL IN EW-1 WILL TURN ON PUMP P-2001
   LOW LEVEL IN EW-1 WILL TURN OFF PUMP P-2001
2. HIGH LEVEL IN EW-2 WILL TURN ON PUMP P-2004
   LOW LEVEL IN EW-2 WILL TURN OFF PUMP P-2004
3. HIGH LEVEL IN EW-3 WILL TURN ON PUMP P-2005
   LOW LEVEL IN EW-3 WILL TURN OFF PUMP P-2005
4. THIS REPRESENTS THE MANUAL SHUTDOWN OF THE ENTIRE SYSTEM (EXCEPT THE CONTROL SYSTEM) ACTIVATED BY THE REMOTE OR LOCAL EMERGENCY SWITCH.
20. LOW LEVEL IN SUMP WILL TURN OFF PUMP P-2002.
21. HIGH LEVEL IN SUMP WILL TURN ON PUMP P-2002.

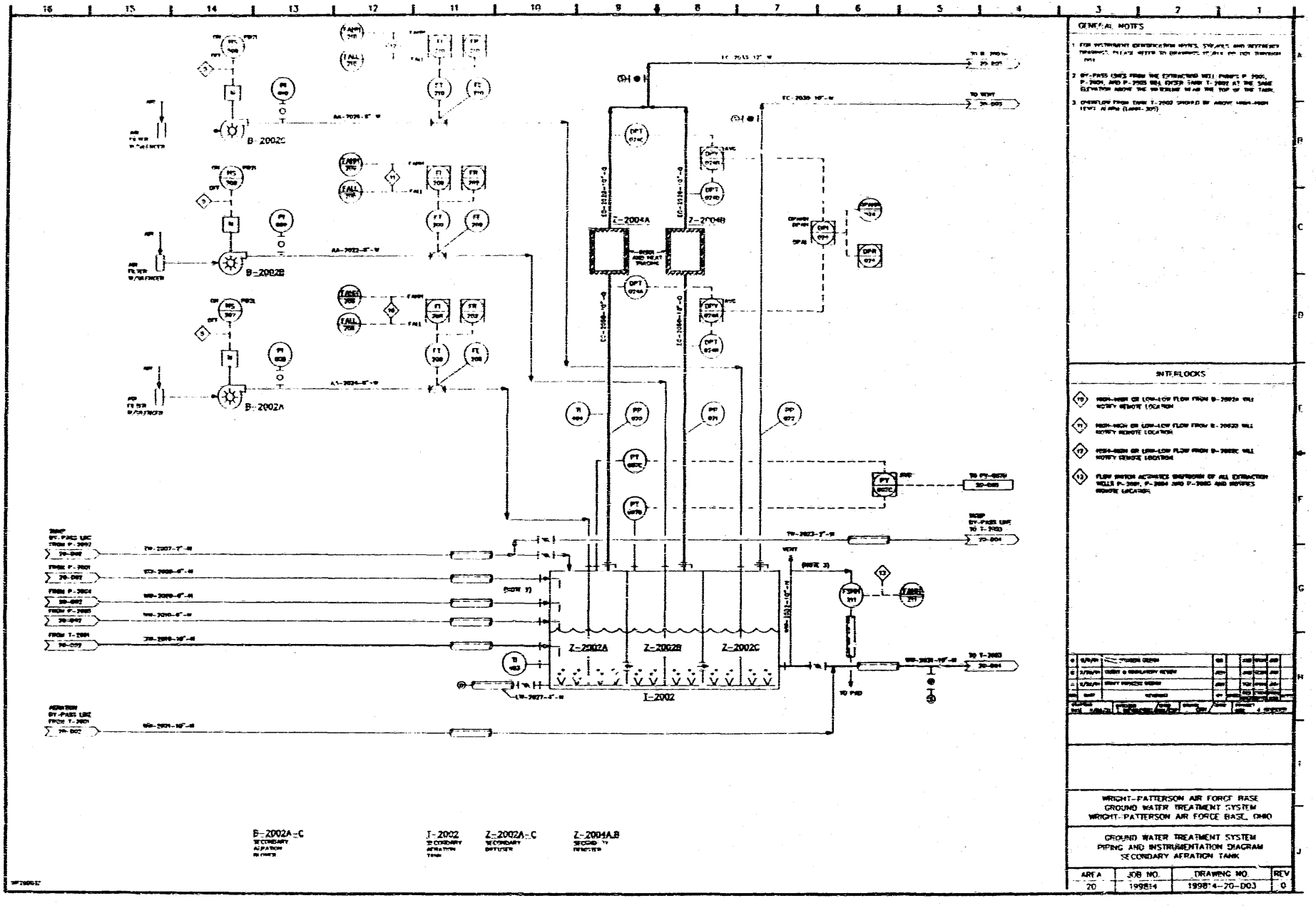
NO.	DATE	REVISION	BY	CHK	APP'D
0	3/31/95	FINAL PERMISS WORK	GS	JMD	JMD
B	3/31/95	AGENCY & REPRESENTATIVE REVIEW	JMM	JMD	JMD
A	2/22/95	DRAFT PERMISS WORK	CMC	TBB	JMD

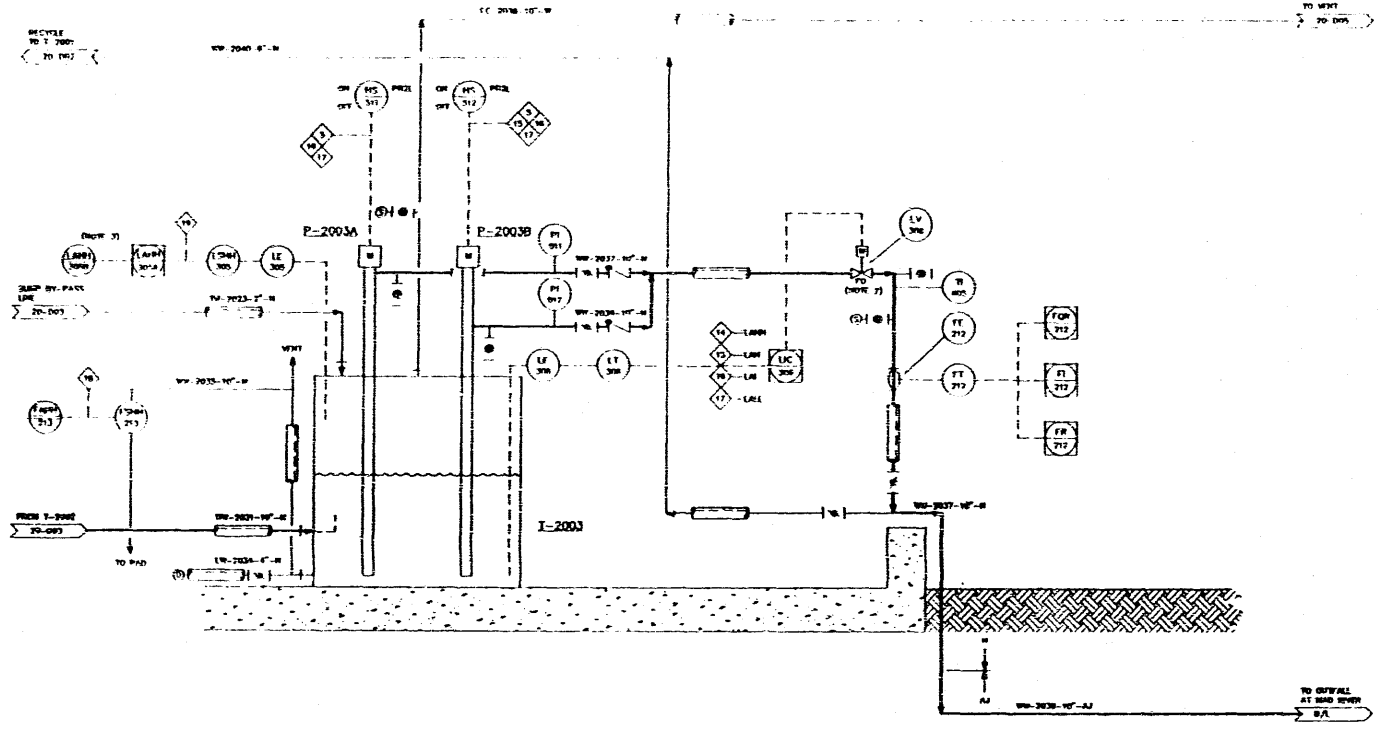
WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
PIPING AND INSTRUMENTATION DIAGRAM
EXTRACTION WELLS AND SUMP

AREA	JOB NO.	DRAWING NO.	REV
20	199814	199814-20-D01	0


GENERAL NOTES
INTERLOCKS
B-2001C
B-2001B
B-2001A
Z-2003A
Z-2003B
Z-2001A
Z-2001B
Z-2001C
I-2001
WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO
GROUND WATER TREATMENT SYSTEM
PIPING AND INSTRUMENTATION DIAGRAM
PRIMARY AERATION TANK
AREA 20
JOB NO 195814
DRAWING NO 195814-20-002
REV 0
B-2001A-C
I-2001
Z-2001A-C
Z-2003A,B


B-2002C
B-2002B
B-2002A
Z-2004A
Z-2004B
Z-2002A
Z-2002B
Z-2002C
I-2002
GENERAL NOTES
INTERLOCKS
B-2002A-C SECONDARY AERATION BLOWER
I-2002 SECONDARY AERATION TANK
Z-2002A-C SECONDARY DIFFUSER
Z-2004A,B SECOND TV INJECTOR
WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO
GROUND WATER TREATMENT SYSTEM
PIPING AND INSTRUMENTATION DIAGRAM
SECONDARY AERATION TANK
ART #
20
JOB NO.
199814
DRAWING NO.
199814-20-D03
REV
0



I-2003 EQUALIZATION TANK

P-2003A,B TREATED WATER DISCHARGE PUMP

GENERAL NOTES

1. FOR EQUIPMENT IDENTIFICATION NOTES, SYMBOLS, AND PIPELINE DRAWINGS, PLEASE REFER TO DRAWING 199814-20-001 THROUGH 006.
2. VALVE ONLY CLOSES UP TO 95 PERCENT.
3. LAHH-305 IS SET HIGHER THAN LAHH-306.

INTERLOCKS

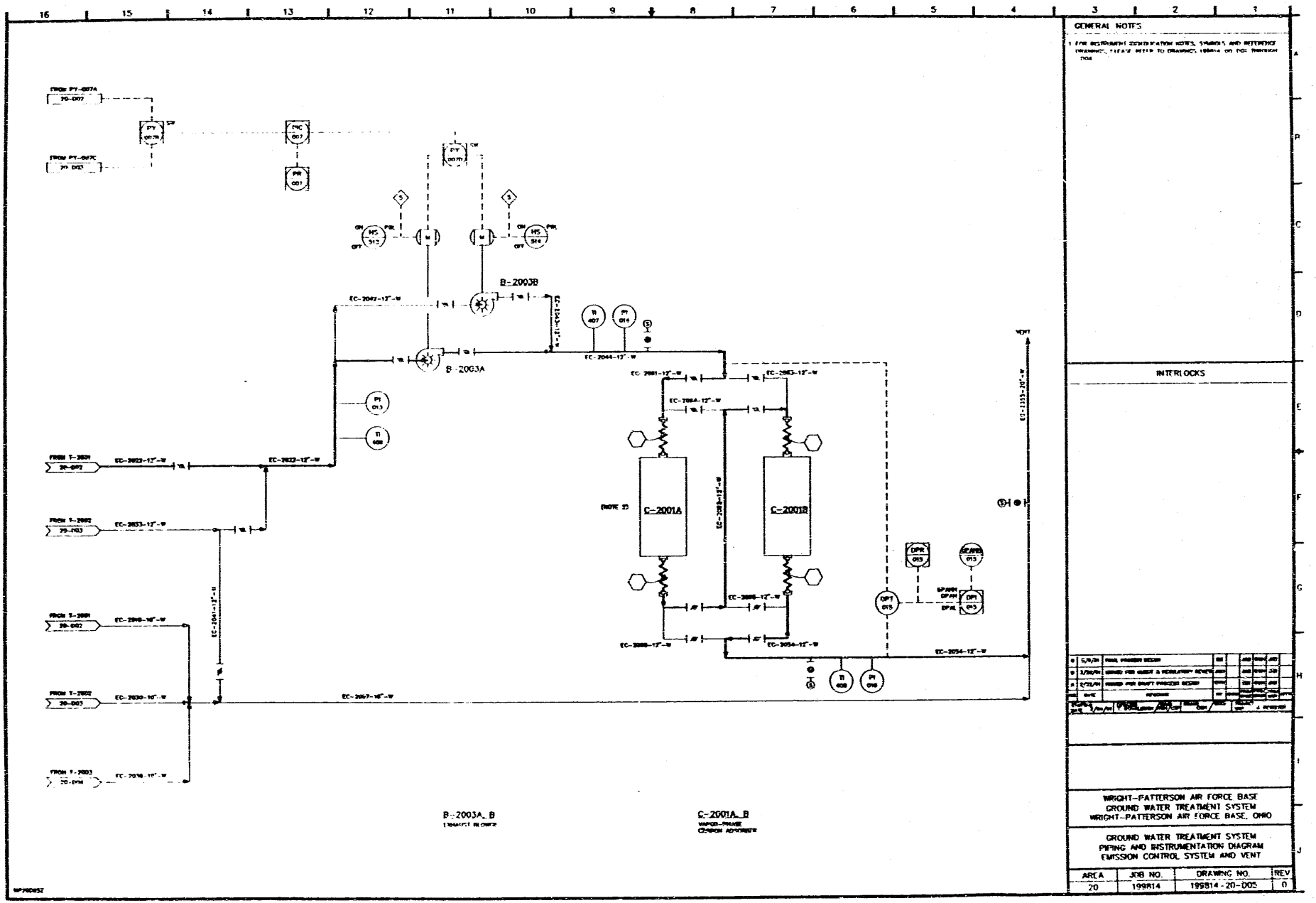
14. HIGH-HIGH LEVEL IN TANK SHUTS DOWN ALL EXTRACTION WELLS P-2001A, B, C AND NOTIFIES REMOTE LOCATION.
15. HIGH LEVEL ACTIVATES SECOND PUMP P-2003B.
16. LOW LEVEL ACTIVATES SECOND PUMP SHUT OFF (P-2003B) OR FIRST PUMP TURN ON (P-2003A).
17. LOW-LOW LEVEL TURNS OFF BOTH PUMPS P-2003A, B AND NOTIFIES REMOTE LOCATION.
18. FLOW SWITCH ACTIVATES SHUTOFF OF ALL EXTRACTION WELLS P-2001A, B, C AND NOTIFIES REMOTE LOCATION.
19. HIGH-HIGH LEVEL IN TANK SHUTS DOWN ALL EXTRACTION WELLS P-2001A, B, C AND NOTIFIES REMOTE LOCATION. THIS INTERLOCK IS REDUNDANT TO INTERLOCK 14 AND 16.

NO.	DATE	REVISION	BY	CHK	APP
0	6/30/99	FINAL PROGRESS ISSUED	MS		
1	2/28/99	ISSUED FOR 60% & REGULATORY REVIEW	AMT		
2	5/28/99	ISSUED FOR DRAFT PROGRESS ISSUED	JDN		

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
PIPING AND INSTRUMENTATION DIAGRAM
DEGASIFICATION AND DISCHARGE

AREA	JOB NO.	DRAWING NO.	REV
20	199814	199814-20-004	0



GENERAL NOTES

1 FOR EQUIPMENT IDENTIFICATION NOTES, SYMBOLS AND REFERENCE DRAWINGS, PLEASE REFER TO DRAWING 199814-20-D01 OF THIS REVISION DOE

INTERLOCKS

REV	DATE	DESCRIPTION	BY	CHK	APP	DATE
0	5/9/01	FINAL PERMITTING DESIGN				
B	3/30/01	ISSUED FOR AGENCY & REGULATORY REVIEW				
A	2/22/01	ISSUED FOR DRAFT PERMITTING REVIEW				

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
PIPING AND INSTRUMENTATION DIAGRAM
EMISSION CONTROL SYSTEM AND VENT

AREA	JOB NO.	DRAWING NO.	REV
20	199814	199814-20-D05	0

13.0 PLOT AND EQUIPMENT ARRANGEMENT PLAN

Plot plans and equipment arragement plans are used to show the approximate location of the process equipment, auxiliary equipment, control room, office, warehouses, etc. Consideration was given to personnel safety, prevention and minimization of fire and explosions, flood protection, ease of maintenance and operation, and economical construction of the facilities.

Area Plot Plan

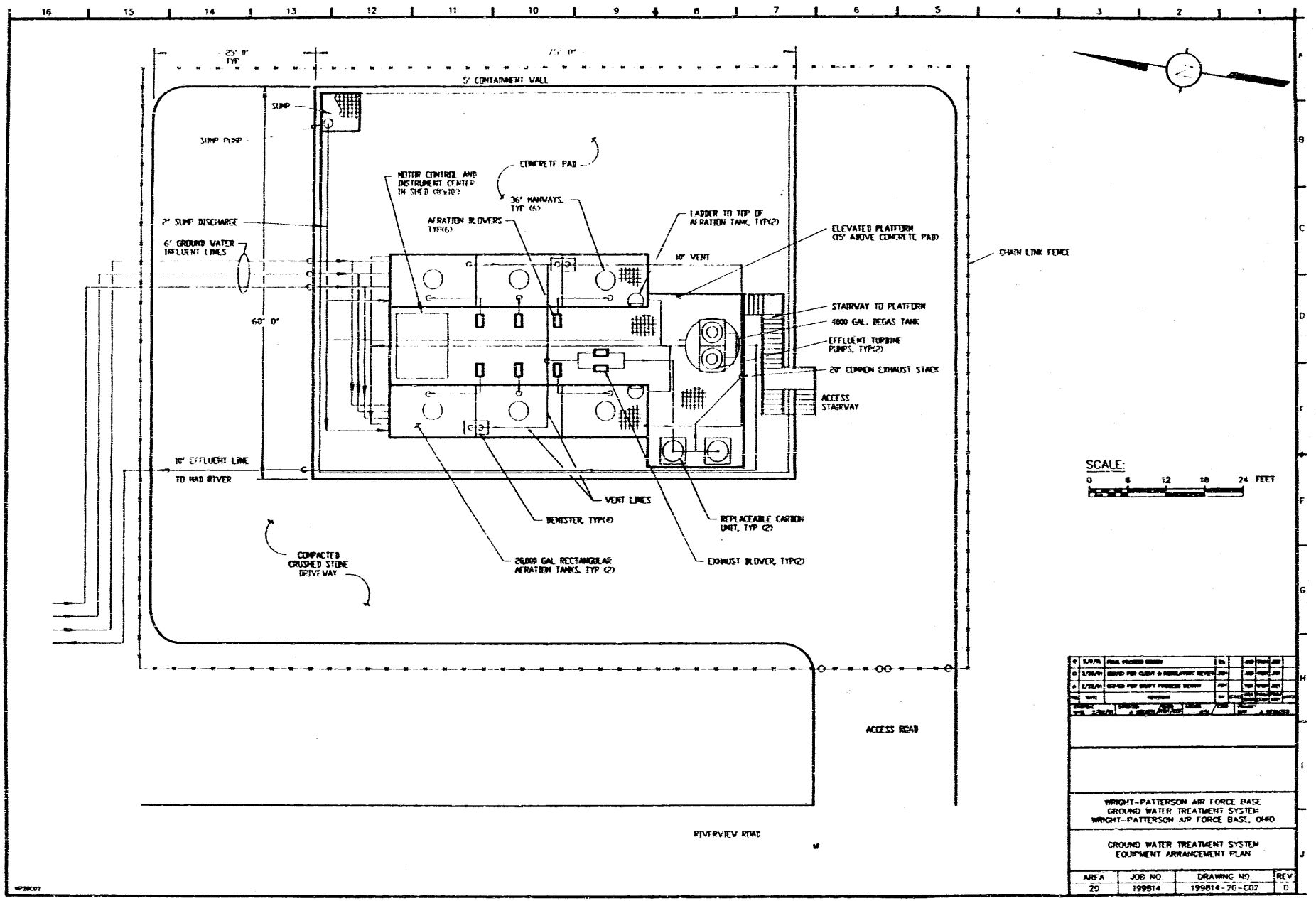
This Plot Plan, shown as Drawing No. 199814-20-C01, shows the location of the overall project in relation to the Base.

Equipment Arrangement

The Equipment Arrangement Plan, Drawing No. 199814-20-C02, shows the location of the process equipment within the treatment system. All equipment is shown as well as large pipelines.

Elevation View

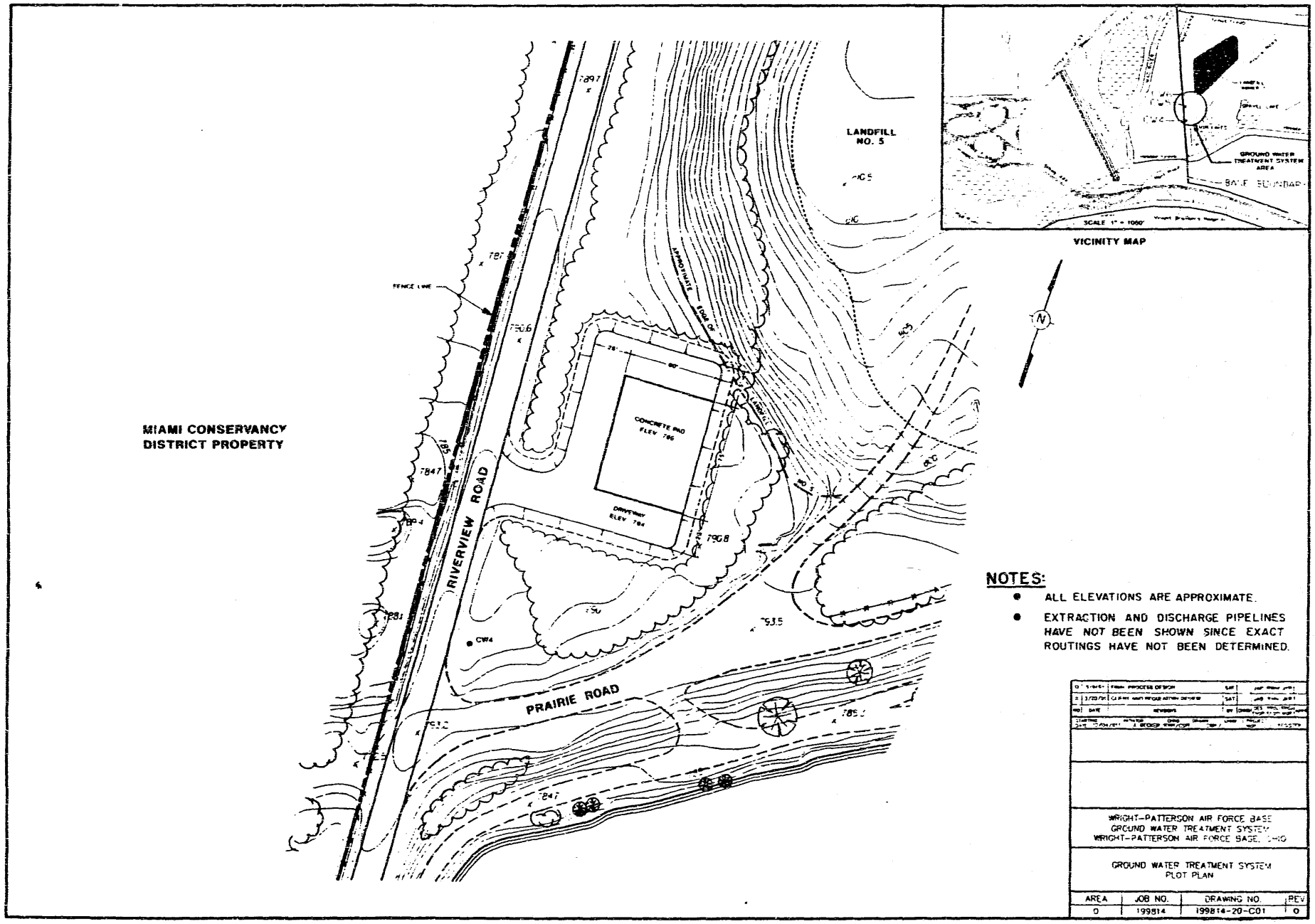
The Western Elevation View, Drawing No. 199814-20-G01, shows a conceptual elevation view of the western side of the GWTS.



WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
EQUIPMENT ARRANGEMENT PLAN

AREA	JOB NO	DRAWING NO	REV
20	199814	199814-20-C02	0



NOTES:

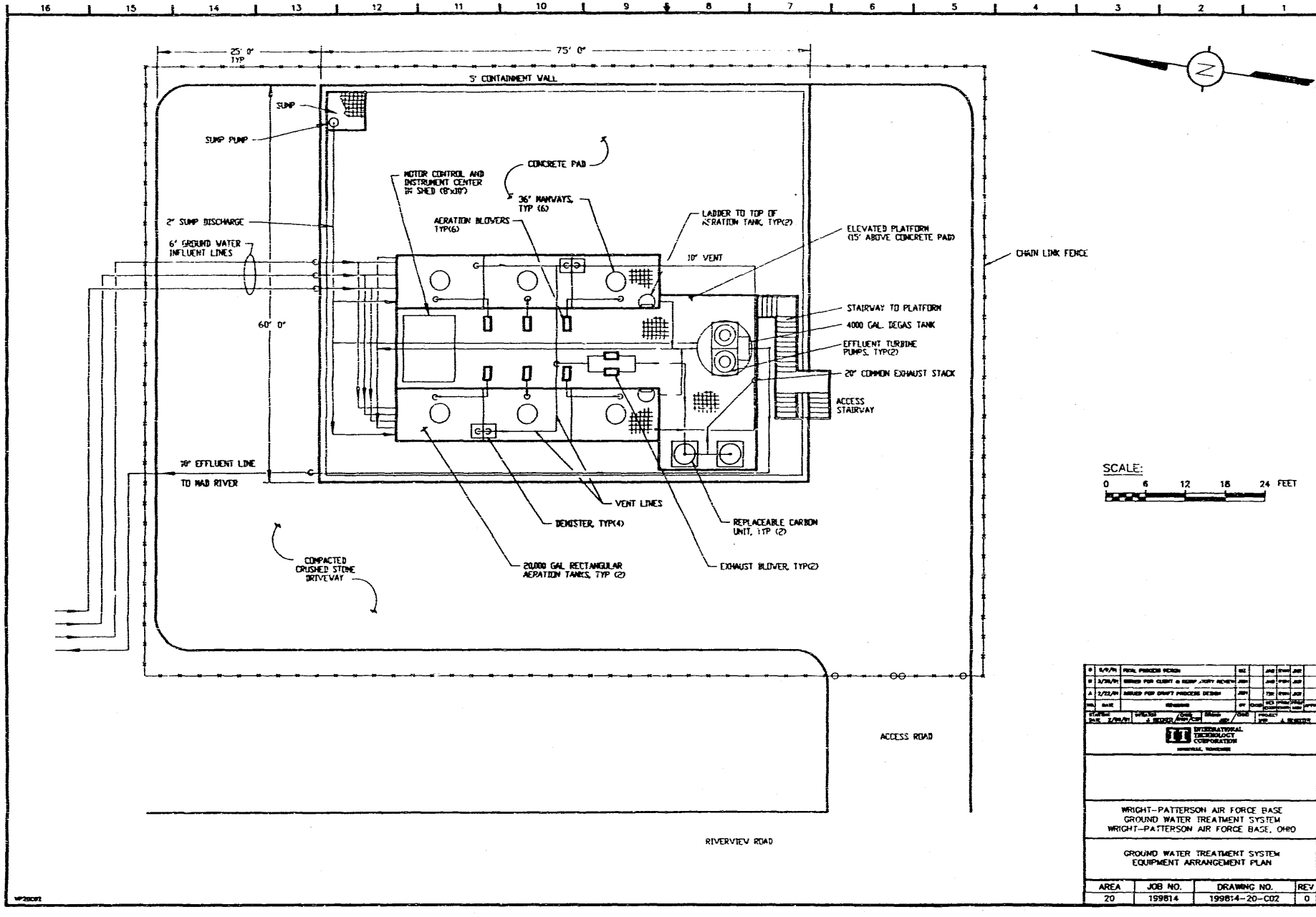
- ALL ELEVATIONS ARE APPROXIMATE.
- EXTRACTION AND DISCHARGE PIPELINES HAVE NOT BEEN SHOWN SINCE EXACT ROUTINGS HAVE NOT BEEN DETERMINED.

NO	DATE	REVISIONS	BY
0	1/14/91	FINAL PROCESS DESIGN	SAT
1	3/20/91	CLEAN AIR FORCE ACTION DEVICE	SAT
2			

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
PLOT PLAN

AREA	JOB NO.	DRAWING NO.	REV
0	199814	199814-20-C01	0



0	5/9/01	FINAL PROCESS DESIGN	MZ		JMB	PWH JMB
B	3/30/01	ISSUED FOR CLIENT & REGULATORY REVIEW	JMH		JMB	PWH JMB
A	3/22/01	ISSUED FOR DRAFT PROCESS DESIGN	JMH		TJM	PWH JMB
NO.	DATE	REVISIONS	BY	CHKD	APVD	

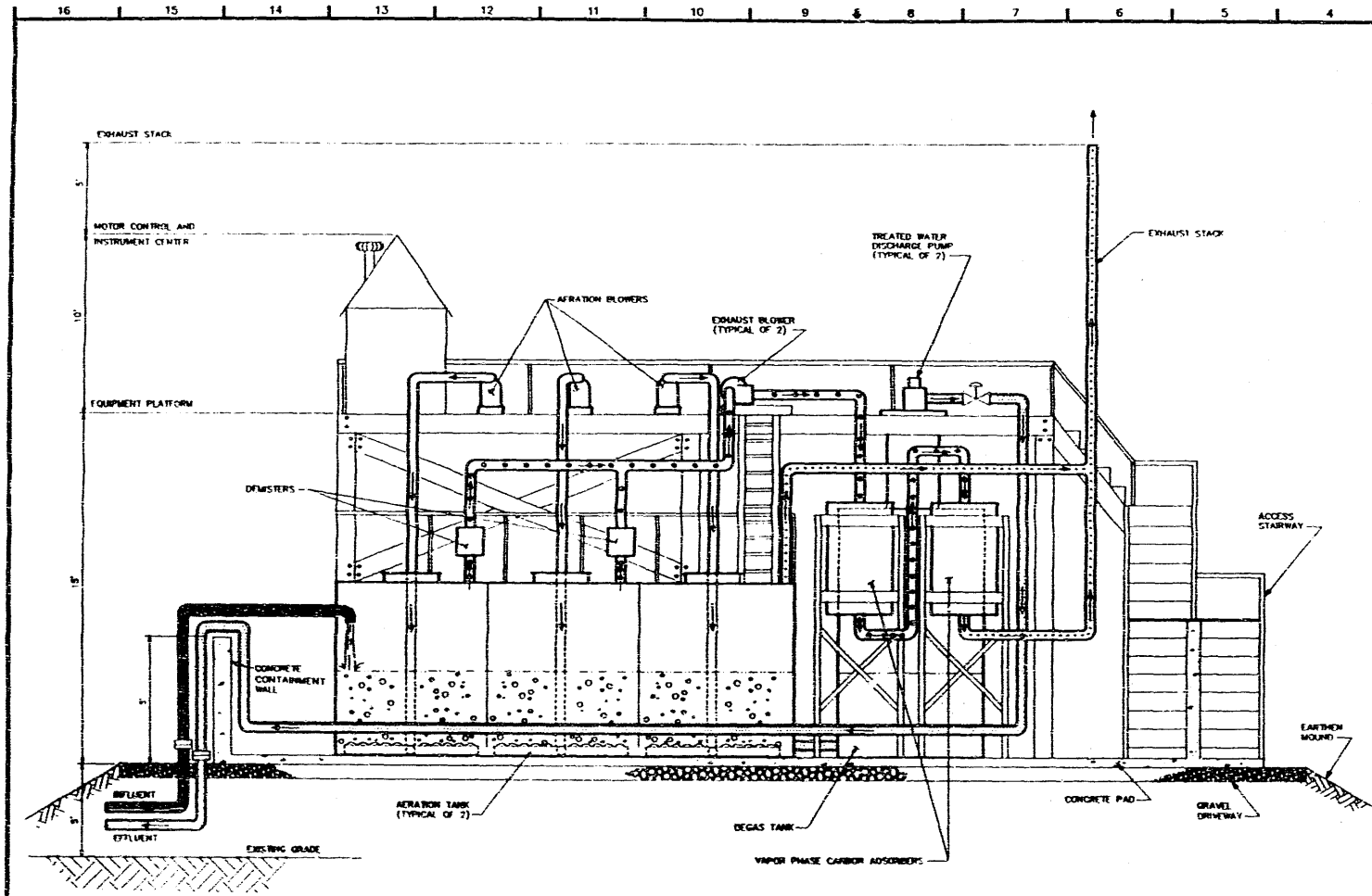
STARTED DATE 3/09/01 | DRAWING NO. | SCALE | DRAWN | CHKD | PROJECT MGR | A. BENEDICT

INTERNATIONAL TECHNOLOGY CORPORATION
IRVINE, CALIFORNIA

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
EQUIPMENT ARRANGEMENT PLAN

AREA	JOB NO.	DRAWING NO.	REV.
20	199814	199814-20-C02	0



WEST ELEVATION VIEW

NOTES

1. THIS DRAWING IS CONCEPTUAL AND SHALL NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

LEGEND:

- AMBIENT AIR
- EXHAUST AIR (>0.50 LBS/DAY TCE @ 800 GPM)
- EXHAUST AIR (<0.23 LBS/DAY TCE @ 800 GPM)
- UNTREATED GROUND WATER (INFLUENT)
- TREATED GROUND WATER (EFFLUENT)

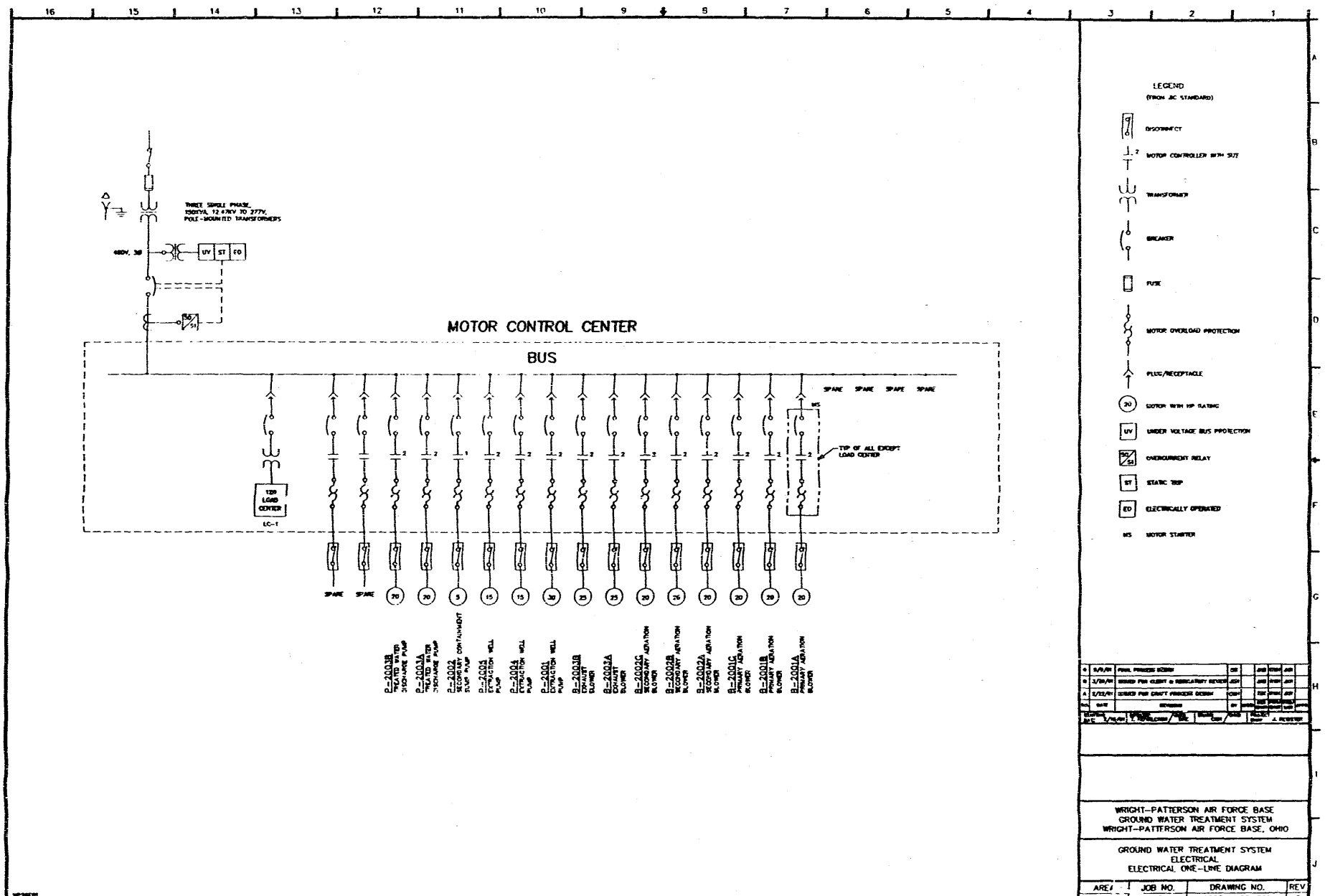
NO.	DATE	REVISION	BY	CHK'D	APP'D
0	6/9/94	[illegible]	[illegible]	[illegible]	[illegible]
B	3/10/94	CLIENT & REGULATORY REVIEW	[illegible]	[illegible]	[illegible]
A	2/14/94	[illegible]	[illegible]	[illegible]	[illegible]

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
WEST ELEVATION VIEW

APP'D	JOB NO.	DRAWING NO.	REV.
[illegible]	[illegible]	[illegible] 20-GD-	0

[redacted]



LEGEND
(FROM JIC STANDARD)

- DISCONNECT
- MOTOR CONTROLLER WITH SIZE
- TRANSFORMER
- BREAKER
- FUSE
- MOTOR OVERLOAD PROTECTION
- PLUG/RECEPTACLE
- (20) MOTOR WITH HP RATING
- UV UNDER VOLTAGE BUS PROTECTION
- 50/51 OVERCURRENT RELAY
- ST STATIC TRIP
- ED ELECTRICALLY OPERATED
- MS MOTOR STARTER

REV	DATE	REVISIONS	BY	CHK	APP
A	5/9/97	FINAL PERMIT DESIGN	DR	JMB	RWM
B	2/26/98	ISSUED FOR AGENCY & REGULATORY REVIEW	JCH	JMB	RWM
C	5/22/98	ISSUED FOR CONST PERMITS DESIGN	CMH	TDR	RWM

WRIGHT-PATTERSON AIR FORCE BASE
GROUND WATER TREATMENT SYSTEM
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

GROUND WATER TREATMENT SYSTEM
ELECTRICAL
ELECTRICAL ONE-LINE DIAGRAM

AREA	JOB NO.	DRAWING NO.	REV
20	199814	199814-20-E01	C

APPENDIX B

DESIGN PACKAGES 1 AND 2

Drawings submitted with Design Packages 1 and 2 are incorporated by reference but are not included because of their size. Copies of these drawings are available upon request.

Addendum to
Design Packages No. 1 and 2

The following presents specific amendments to Design Packages 1 and 2 prepared by Barge, Waggoner, Sumner, and Cannon. The amended portions of the Design Packages are marked and correspond to the comments listed below. These amendments were prepared in response to comments from the U.S. EPA on the 90 percent Design Packages. Because IT Corporation (IT) was contracted to perform the construction for Tasks 1 and 2 of Phase II, Design Packages 1 and 2 were not finalized as a bid package. Comments and questions concerning the contents of the drawings and specifications, as listed below, were addressed as field modifications rather than as design package modifications. The following amendments reflect actual field conditions and will subsequently be incorporated into the as-built construction report.

Engineering Drawings (not included in the accompanying Design Package)

1. Drawing C1

- The beginning of the discharge line was located relative to the fence along Riverview Road. The first point was located at STA 28+50 where the North/South and East/West fence intersect. All other stations are located relative to this point according to the station designations on Drawing C1.

- The beginning of the discharge pipeline was specified at an arbitrary high positive number (9+60) so that if changes were made to the drawing and the pipeline was extended, the station number would still be positive. The as-built drawing of the discharge pipeline will be on the State plane coordinate grid. The pipeline location will be identified relative to two on-site monuments located approximately 1-1/2 miles from the location of the treatment system embankment.

- Cleanouts are being installed in the discharge pipeline to provide access in the event that the line becomes clogged with debris or sediment (i.e. from the river during a treatment system downtime). Although the cleanouts require excavation to access, they are easy to install during pipe installation and minimize the need to remove and repair a section(s) of pipe to perform line maintenance. Installation of a manhole or manway for access to the cleanouts was evaluated but not recommended since a manway would require provision for freeze protection, routine maintenance, as well as a mechanism for securing the manway against unauthorized access.

- The offset between STA 28+50 and STA 30+20 is indicated on Drawing C1 as STA 29+50.

- The pipeline material is specified in the Project Manual for Design Package No. 2. Drawing C1 will be revised for the as-built package and will not contain the pipeline material specifications.

- The primary purpose of Drawing C1 is to show the route of the discharge pipeline and the approximate location of the treatment system embankment. The embankment location is shown on Drawing C2.

2. Drawing C2

- The stability of the embankment under flood conditions has been verified by an independent geotechnical engineering firm based on the use of pit run gravel which has been selected for the embankment construction.

- The embankment has been located using the station designations shown on Drawing C1 and the dimensions provided on Drawing C2. The embankment was surveyed for location relative to the route of the discharge pipeline.

- The existing topographic contour lines will be distinguished from the new contour lines on the as-built drawings.

3. Drawing C3

- The ground line was field verified prior to the start of construction activities.

- The water level of the Mad River will be shown on the as-built drawing.

4. Drawing C4

- The thrust blocking design has been confirmed with the piping manufacturer.

- As constructed, the backfill section will be revised for the as-built drawing to reflect the use of No. 57 crushed stone for layers A through D.

- The bituminous surface treatment is specified in Section 2513 of the Project Manual. The thickness of the bituminous surface will be approximately 2-inches based on 2 layers each of tar-seal and crushed aggregate.

- The specifications are sufficient to select standard manufactured fence posts and gates. Details of the gate and fence posts will be available in the as-built package either as a manufacturer's drawing or as a detail on the drawings. The width of the gate will also be shown.

- In preparing for the outfall construction, provisions have been made to control the river water during construction and curing of the outfall structure using techniques similar to trench shoring.

Project Manual

5. Table of Contents, Page 00001-1

The Earthwork and Road Construction and the Discharge Pipeline Installation (Design Packages No. 1 and 2) was conducted by IT and therefore bid documents were not incorporated in the Project Manual for these tasks. Bids will be solicited for execution of the work scopes for Design Packages No. 3, 4, and 5. A bid document will accompany each design package and will include an invitation to bid, instruction to bidders, a bid form, contract form, and general conditions in addition to the specifications and drawings. A copy of the Phase II Work Plan and the Phase II Health and Safety Plan will also be submitted along with the bid document.

6. Section 02105

The Phase II Health and Safety Plan, Sections 2.3, Task-Specific Hazards and Controls, and 2.5, Personal Protective Equipment apply to this section. In the case of a flood, the site must be evacuated.

7. Section 02203

"Acceptable material" in this section refers to material that will be sufficient to achieve the design specifications. The specifications require that the fill material is compacted to a density of 98 percent of Standard Proctor and that a 1:1 slope is achieved and maintained. It is the responsibility of the contractor to select material that can be compacted to the design specifications in an efficient manner and that will maintain a 1:1 slope. Prior to initiation of construction, the contractor will identify local vendors of fill material, submit a representative sample of each source of fill for Standard Proctor density testing, and will perform the engineering verification that the selected material will achieve the 1:1 slope.

8. Section 02221, Paragraph 3.7

Because the shallow water table is greater than 10 feet below grade at most of the work areas and the maximum depth of any excavation is 7 feet below grade, it is not anticipated that dewatering will be required. During installation of the Stage 1 discharge pipeline within close

proximity to the Mad River, some perched water above the shallow water table may be encountered. Because the maximum depth of the trench excavation near the Mad River will be 6 feet below grade, however, it is not anticipated that dewatering will be necessary to complete the last few sections of pipe. If dewatering is necessary, the water will be contained, tested for VOCs, and disposed of in accordance with the procedures for handling project-generated wastes as outlined in the RI/FS Work Plan.

9. Section 02444

WPAFB has indicated that no additional specifications are required for the installation of fencing at the Base.

10. Section 02722, Paragraph 3.2, Subparagraph D

The description of the pipe testing procedures are revised to reflect the use of water. The hydrostatic test is to be conducted in accordance with the manufacturer's instructions. Leak detection at the joints is to be conducted by observing the joints for wetness while the pipe is pressurized.

11. Section 03301

The amount of concrete necessary for construction of the outfall is approximately 20 cubic yards with significantly less required for the thrust blocks. Upon review of the specifications in Paragraph 3.11.B, the testing specified in Paragraph 3.11.A of Section 03301 was determined to be unnecessary based on the limited amount of concrete work required to complete the task. The procedures outlined for concrete placement will be otherwise adhered to as specified.

PROJECT MANUAL
Documents and Specifications

INSTALLATION RESTORATION PROGRAM
WRIGHT-PATTERSON AIR FORCE BASE

ENVIRONMENTAL INVESTIGATION OF GROUND WATER CONTAMINATION

PHASE II GROUND WATER REMOVAL ACTION

DESIGN PACKAGE NO.1 - EARTHWORK AND ROAD CONSTRUCTION

DESIGN PACKAGE NO.2 - DISCHARGE PIPELINE

BATTELLE ENVIRONMENTAL MANAGEMENT OPERATION
DAYTON, OHIO

WRIGHT - PATTERSON AIR FORCE BASE
2750 AIR BASE WING
OFFICE OF ENVIRONMENTAL MANAGEMENT
WRIGHT - PATTERSON AIR FORCE BASE, OHIO

PROCESS DESIGN BY:

IT CORPORATION
KNOXVILLE, TENNESSEE
CINCINNATI, OHIO

CONSTRUCTION PLANS & SPECIFICATIONS BY:

BARGE, WAGGONER SUMNER & CANNON

SUITE 2400 - PLAZA TOWER
KNOXVILLE, TENNESSEE 37929
(615) 637-2810

8755 GANDER CREEK DRIVE
MIAMISBURG, OHIO 43542
(513) 438-0378

SUBMITTED BY:

Barry K Quinn 5/31/91

STATE OF OHIO
BARRY
K.
QUINN
E-53662
REGISTERED
PROFESSIONAL ENGINEER

ISSUED: APRIL 1991

FILE: 12539-02

SET:

Barge Waggoner Sumner and Cannon

Engineers, Architects, Planners, Landscape Architects and Surveyors

TABLE OF CONTENTS

GENERAL

This project manual follows the BWS&C Master Format Document Identifying System and Cost Accounting Numbers.

Nonapplicable division and section references have been omitted.

Recipients of bidding instruments must consult the Table of Contents to determine the full scope of the work involved and to ensure that all pages of the project manual and drawings have been included. (5)

Neither the Owner nor the A/E will be responsible for bids submitted that are based on incomplete bidding instruments.

GENERAL REQUIREMENTS

Refer to the contract documents for General Requirements of Wright-Patterson Air Force Base. (5)

END OF SECTION

SECTION 02105

PROTECTION

PART 1. GENERAL

1.1 The general intent of this section is to establish both the extent of protection which the Contractor and his subcontractors are required to provide beyond that considered normal or specified above, and the penalties if such protection is not provided.

1.2 Personally caution subcontractors before they move on the site as to the protection required for their work and the penalties involved. (6)

PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

3.1 Adequately mark all existing construction, utilities, trees, or plant life that the drawings indicate are to remain before any work is started. The A/E will verify all trees, etc., that are to be removed.

3.2 Box in all trees that are to remain. Then cut and remove from the site all trees that are to be removed.

3.3 Completely remove all stumps and roots from cut trees.

3.4 Any trees that are to remain which receive damage shall be immediately repaired by a qualified tree surgeon.

3.5 Where the finished grade is to be raised around trees that are to remain, provide gravel graded to a diameter of between 1 inch and 2 inches,, and distribute this gravel over the full area of the tree spread affected by the grade change. Slope the gravel up against the tree trunk, and project it 3 inches above the finished grade for a horizontal distance of 12 inches all around the tree trunk. Place the finish material specified elsewhere over the rock.

3.6 Where the finished grade is to be lowered close to trees that are to remain, carefully excavate by hand to avoid damaging the root structure. Cut any roots that must be removed and that have a diameter of 1-1/2 inches or less, and then paint the cuts with a commercial tree paint. If roots over 1-1/2 inches in diameter require cutting or if the number of roots that need cutting is excessive, notify the A/E.

3.7 Branches shall be removed only by a qualified tree surgeon.

3.8 If any trees not designated for removal are destroyed, replace them with trees of equal species and size. If replacement has not been made or proper credit based on estimated replacement cost not issued at the time for final payment, the Owner's due credit will be subtracted from the Contractor's retainage and final payment.

3.9 Repair or replace existing construction, utilities, etc., either to original condition or to the satisfaction of the A/E and/or Owner.

END OF SECTION

SECTION 02110

CLEARING AND GRUBBING

PART 1. GENERAL

1.1 This work consists of clearing, grubbing, removing, and disposing of all debris and of all vegetation, buildings, and foundations not removed by others that are within designated construction areas, except for such objects that the A/E designates to remain. The work shall also include preserving and protecting from injury or defacement all vegetation and objects designated to remain.

1.2 The A/E will designate all trees, shrubs, plants, and other items that are to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention shall be an asphaltum base paint prepared especially for tree surgery and approved by the A/E.

PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

3.1 Clear the entire construction area of all weeds, brush, briars, bushes, trees, stumps, and other protruding obstructions not designated to remain, except within any areas which the A/E may designate to remain undisturbed.

3.2 Perform all clearing and grubbing operations in accordance with the applicable provisions for erosion control as specified and as required by local authorities.

3.3 Completely dispose of all materials resulting from clearing and grubbing off the site.

END OF SECTION

[redacted]

contain enough moisture for proper compaction to be obtained, thoroughly scarify and break the subgrade to a minimum depth of 6 inches, increase the moisture content, and then compact the subgrade. For material that is unstable because of moisture but is otherwise suitable for the subgrade, either scarify, allow to dry, and compact or else remove and use for refill or embankment. Manipulation to speed drying will be permitted.

1.8 USE OF EXCAVATED MATERIALS

A. Material excavated at the site shall not be used for backfill or embankment construction. All excavated materials shall be disposed of at approved sites.

1.9 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction

Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2992 (nuclear density method), as applicable.

2. Footing subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.

3. Paved Areas and Embankment Areas: Make at least one field density test of subgrade for every 2,000 sq. ft. of paved area or embankment area, but in no case less than three tests. In each compacted fill layer, make one field density test for every 2,000 sq. ft. of overlaying paved area or embankment area, but in no case less than three tests.

B. If in opinion of Architect/Engineer, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

NOT USED

END OF SECTION

SECTION 02203

EMBANKMENT

PART 1. GENERAL

1.1 This work shall consist of forming embankments, other than for building pads, with materials from excavation or other approved sources and in conformance with the lines, grades and cross-section shown on the drawings.

1.2 Complete the clearing and grubbing of embankment areas in accordance with the requirements of Section 02110 before placing embankment thereon.

1.3 Submit plans for erosion control to the A/E for approval, conduct all embankment operations in accordance with the erosion control plan approved by the A/E.

1.4 Embankment under building pads shall be in accordance with recommendations from the Geotechnical Engineer.

PART 2. PRODUCTS

2.1 Use only acceptable materials in embankment formation. Place no frozen material, stumps, logs, roots or other perishable materials in any embankment. Place no stone or masonry fragment greater than 3 inches in any dimension within 12 inches of the finished subgrade elevation. (7)

PART 3. EXECUTION

3.1 Remove all topsoil and unsatisfactory material from all embankment areas prior to placing embankment material.

3.2 Form soil, soft sandstone, weathered rock, bank gravel or creek gravel embankment by distributing the material in successive uniform horizontal layers no more than 6 inches thick (loose depth) to the full width of the cross-section. However, layers less than 6 inches in loose thickness may be required whenever necessary to obtain the specified density. Compact each layer as specified below. Shape the upper surface of the embankment so as to provide complete drainage of surface water at all times. The forming of ruts will not be permitted.

3.3 Compact the embankment to a density of at least 98% of the maximum density as determined by ASTM D698 (Standard Proctor).

3.4 During compaction, embankment material that does not have enough moisture for proper compaction, shall have water added and thoroughly mixed as necessary to obtain proper compaction. Embankment material containing an excess of moisture shall be allowed to dry before compacting; manipulating as necessary to speed drying.

3.5 Perform construction operations so that simultaneous rolling and placing of material in the same lane or section is prevented. To avoid uneven compaction, see that hauling equipment traverses the full width of the cross-section as much as possible. Compact each layer as necessary before depositing material for the next layer.

3.6 The density requirements shall be the controlling factor in compaction. Use only such equipment as will satisfy the density requirements at all times.

3.7 When embankment is placed around adjoining or opposite faces of a structure, compact it to the same level on all sides before proceeding to the next layer. As precaution against wedging action, begin compaction for each layer next to the structure.

3.8 Construct embankments adjacent to structures as outlined to the height of the structure and slope far enough away from the structure to permit easy access of compacting equipment used in normal embankment construction.

3.9 Whenever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered, remove it and continue excavation until suitable material is encountered. The material removed shall be disposed of. Then refill the areas excavated for this reason with 1 inch to 2 inches crushed stone then proceed with embankment construction.

END OF SECTION

SECTION 02221

UNCLASSIFIED EXCAVATION FOR UTILITIES

PART 1. GENERAL

1.1 The work called for by this section shall consist of clearing and grubbing, loosening, loading, removing, and disposing of, in the specified manner, all wet and dry materials (including rock) encountered that must be removed for construction purposes; furnishing, placing, and maintaining all sheeting, shoring, bracing, and timbering necessary for the proper protection and safety of the work, the workmen, the public, and adjacent property and improvements; the dewatering of trenches and other excavations; the preparation of satisfactory pipe beds; the backfilling and tamping of trenches, foundations, and other structures; the preparation of fills and embankments; the removal of unsuitable material from outside the normal limits of excavation and, where ordered by the A/E, their replacement with suitable materials; and all other grading or excavation work incidental to or necessary for the work. This work shall be performed as specified below.

PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

3.1 PREPARATION OF THE SITE

A. Before starting construction, remove from the work site all vegetable growth (except as hereinafter excluded), debris, and/or other objectionable matter as well as any buildings and/or other structures that the drawings and/or the A/E specifically indicate are to be removed. Dispose of this refuse material in a manner acceptable to the A/E.

B. In certain areas it may be desirable for existing trees, shrubs, or other vegetation on the site to be preserved for the permanent landscape. Such vegetation may be shown on the drawings, specifically listed in the specifications, marked on the site, or identified by the A/E. In no case damage or remove such growth without written permission from the Owner.

C. If the area to be excavated is occupied by trees, brush, or other vegetable growth, clear such growth and grub the excavated area, and remove all large roots to a depth of not less than 2 feet below the bottom of the proposed construction. Dispose of the growth removed in a manner satisfactory to the A/E. Fill all holes or cavities

created during this work that extend below the subgrade elevation with suitable material, and compact to the same density as the surrounding material.

D. Trees, cultivated shrubs, etc., that are situated within public rights-of-way and/or construction easements through private property but not directly within the excavation area shall remain undisturbed unless it is necessary to remove them so that the work can be performed safely and unless their removal is specifically ordered by the A/E. Take special precautions to protect and preserve such growth throughout all stages of the construction.

E. Preparation of the site shall be considered an integral part of the excavation and one for which no separate payment shall be allowed.

F. Trenches in roadways shall be pre-cut with a pavement saw prior to beginning excavation.

3.2 UNSUITABLE MATERIALS

A. Wherever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered, remove it and continue excavation until suitable material is encountered. The material removed shall be disposed of in the manner described below. Then refill the areas excavated for this reason with 1 inch to 2 inches crushed stone up to the level of the lines, grades, and/or cross sections shown on the drawings. The top 6 inches of this refill shall be No. 67 (ODOT) crushed stone for bedding.

3.3 ROCKS AND BOULDERS

A. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements, and/or similar materials, shall be considered as unclassified excavation, and no separate payment will be made therefor.

B. Excavate rock over the horizontal limits of excavation and to a depth of not less than 6 inches below the outside bottom of pipe up to 30 inches in diameter and not less than 12 inches below the outside bottom of larger pipes if rock extends to such depth. Then backfill the space below grade with No. 67 (ODOT) crushed stone or other approved material, tamp to the proper grade, and make ready for construction. For monolithic concrete sewers or culverts and for structures, excavate rock to the outside bottom of the structure or sewer.

3.4 DISPOSAL OF MATERIALS

A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the drawings or directed by the A/E shall be used for these purposes. Any materials not so used shall be considered waste materials and disposed of by the Contractor as specified below.

B. Waste materials may be deposited in spoil areas at locations approved by the A/E. Do not leave in unsightly piles but instead spread in uniform layers, neatly level, and shape to drain. Seed as specified in Section 02485, Seeding.

C. Once any part of the work is completed, properly dispose of all surplus or unused materials (including waste materials) left within the construction limits of that work. Leave the surface of the work in a neat and workmanlike condition, as described below.

D. The disposal of waste materials shall be considered an integral part of the excavation work and one for which no separate payment shall be allowed.

3.5 EXCAVATION FOR TRENCHES, MANHOLES, AND STRUCTURES

A. Unclassified excavation for pipelines shall consist of the excavation necessary for the construction of water, sewer, and other pipes and their appurtenances (including manholes, inlets, outlets, headwalls, collars, concrete saddles, and pipe protection) that are called for by the drawings. It shall include clearing and grubbing where necessary, backfilling and tamping pipe trenches and around structures, and disposing of waste materials, all of which shall conform to the applicable provisions set forth elsewhere in these specifications.

B. The Contractor may, if he chooses, use a motor powered trenching machine. If he does, however, he shall be fully responsible for the preservation or repair of existing utility service connections.

C. Unless the construction of lines by tunneling, jacking, or boring is called for by the drawings or specifically authorized by the A/E, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the A/E on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula:

4/3d + 15 inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by the A/E, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to nonvertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula 4/3d + 15 inches shall be at the expense of the Contractor and may be cause for the A/E to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

D. For rigid pipe, shape the bottom of all trenches to provide uniform bearing for the bottom of the pipe barrel. For plastic sewer lines, provide a minimum of 6 inches of No. 67 (ODOT) crushed stone for bedding.

E. Excavate bell holes for bell and spigot pipe at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper jointing of the pipe. Do not excavate bell holes more than 2 joints ahead of pipe laying.

F. Excavation for manholes, inlets, and other incidental structures shall not be greater in horizontal area than that required to allow a 2 foot clearance between the outer surface of the structure and the walls of the adjacent excavation or of the sheeting used to protect it. The bottom of the excavation shall be true to the required shape and elevation shown on the drawings. No earth backfilling will be permitted under manholes, inlets, headwalls, or similar structures. Should the Contractor excavate below the elevations shown or specified, he shall, at his own expense, fill the void with either concrete or granular material approved by the A/E.

G. Do not excavate pipe trenches more than 1500 feet ahead of the pipe laying unless approved by the A/E, and perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the A/E deems necessary to maintain vehicular or pedestrian traffic.

H. In all cases where materials are deposited along open trenches, place them so that in the event of rain or surcharge loading from such deposits no damage will result to the work and/or to adjacent property.

I. Excavation for manholes and other structures may be performed with nonvertical banks except beneath pavements or adjoining existing improvements. Do not permit the horizontal area of the excavation to exceed that required

to allow a 2 foot clearance between the outer surface of the structure and the banks of the excavation or the sheeting used to protect the embankments. The bottom of the excavation shall be true to the required shape and elevation shown on the drawings.

3.6 SHEETING, SHORING, AND BRACING

A. Take special care to avoid damage wherever excavation is being done. Sufficiently sheet, shore, and brace the sides of all excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to withstand the pressures exerted, to keep the walls of the excavation properly in place, and to protect all persons and property from injury or damage. Separate payment will not be made for sheeting, shoring, and bracing, which are considered an incidental part of the excavation work.

B. Wherever employees may be exposed to moving ground or cave-ins, shore and lay back exposed earth excavation surfaces more than 5 feet high to a stable slope, or else provide some equivalent means of protection. Effectively protect trenches less than 5 feet deep when examination of the ground indicates hazardous ground movement may be expected. Guard the walls and faces of all excavations in which employees are exposed to danger from moving ground by a shoring system, sloping of the ground, or some equivalent protection.

C. Comply with all OSHA standards in determining where and in what manner sheeting, shoring, and bracing are to be done. The sheeting, shoring, and bracing system shall be designed by a professional engineer licensed in the State of Ohio and shall be subject to approval by the A/E. However, such approval does not relieve the Contractor of the sole responsibility for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of sheeting, shoring, and bracing.

D. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the sides of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent structures wherever necessary, with the approval of the A/E.

E. Do not leave sheeting, shoring, or bracing materials in place unless this is called for by the drawings, ordered by the A/E, or deemed necessary or advisable for the safety or

protection of the new or existing work or features. Remove these materials in such a manner that the new structure or any existing structures or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are avoided.

F. Fill and compact all holes and voids left in the work by the removal of sheeting, shoring, or bracing as specified herein.

G. The Contractor may use a trench box, which is a prefabricated movable trench shield composed of steel plates welded to a heavy steel frame. The trench box shall be designed to provide protection equal to or greater than that of an appropriate shoring system.

3.7 THE DEWATERING OF EXCAVATION

A. Provide and keep in operation enough suitable pumping equipment whenever necessary or whenever directed to do so by the A/E. Give special attention to excavations for those structures that, prior to proper backfilling, are subject to flotation from hydrostatic uplift. (8)

3.8 BACKFILLING

A. Begin backfilling after the line construction is completed and then inspected and approved by the A/E. On each side of the line, from the bottom of barrel to 1 foot above the top of the pipe, the backfill material shall consist of No. 67 (ODOT) stone . Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than 6 inches deep. Thoroughly and completely tamp each layer into place before placing additional layers. Where stone backfill is required, compact to 95 percent relative density ASTM D 2049.

B. If plastic sewer pipe is used, install No. 67 (ODOT) crushed stone in a 6 inch envelope on all sides of the pipe. Then add the remaining backfill up to 1 foot above the top of the pipe as described in the previous paragraph.

C. Material shall be placed at locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement, tamp and thoroughly compact the backfill in layers that, before compaction, are 6 not greater than inches deep. In other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.

D. If earth material for backfill is, in the opinion of the A/E, too dry to allow thorough compaction, then add enough water so that the backfill can be properly compacted. Do not place earth material that the A/E considers too wet or otherwise unsuitable.

E. Wherever excavation has been made within easements across private property, the top 1 foot of backfill material shall consist of fine loose earth free from large clods, vegetable matter, debris, stone, and/or other objectionable materials.

F. Conduct backfilling around manholes, inlets, outfalls, and/or structures in the same manner as specified above for pipelines except that even greater care is necessary to prevent damage to the utility structure.

G. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary, whenever directed to do so by the A/E.

H. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the A/E's requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.

I. Compaction Requirements: Under buildings and 2 times the depth of pipe beyond, and under roads and 2 times the depth beyond the shoulder, compact to 95% maximum density in accordance with ASTM D698. In all other locations, compact to 90% maximum density.

3.9 MAINTENANCE

A. Seed and maintain in good condition all excavated areas, trenches, fills, embankments, and channels until final acceptance by the Owner.

B. Maintain trench backfill at the approximate level of the original ground surface by periodically adding backfill material wherever necessary and whenever directed to do so by the A/E. Continue such maintenance until final acceptance of the project, or until the A/E issues a written release.

3.10 SLOPES

A. Neatly trim all open cut slopes, and finish to conform either with the slope lines shown on the drawings or the directions of the A/E. Leave the finished surfaces of

bottom and sides in reasonably smooth and uniform planes like those normally obtainable with hand tools, though the Contractor will not be required to use hand methods if he is able to obtain the required degree of evenness with mechanical equipment. Conduct grading operations so that material is not removed or loosened beyond the required slope.

END OF SECTION

SECTION 02444

GALVANIZED CHAIN LINK FENCE GATE

PART 1. GENERAL

1.1 If alternative materials are proposed, submit complete specifications and shop drawings for the A/E's approval.

1.2 Fencing and all accessories shall be produced by a single manufacturer. Submit 2 copies of the manufacturer's technical data and installation instructions.

PART 2. PRODUCTS

2.1 POSTS, RAILS, AND BRACES

A. All structural and roll formed shapes shall conform to the provisions of ASTM A123 for galvanized coating.

B. All tubular members shall comply with the provisions of ASTM A120, Schedule 40, for weight and coating or be high strength triple coated steel in accordance with ASTM A569.

C. Gate Posts:

1. Gate Leaves Up To and Including 6 feet 0 inches Wide: 3-1/2 inches by 3-1/2 inches roll formed section (2.875 inches outside diameter, Schedule 40 or high strength steel pipe)

2. Gate Leaves Over 6 feet 0 inches and Up To and Including 13 feet 0 inches Wide: 4 inches outside diameter, Schedule 40 pipe or high strength steel pipe

3. Gate Leaves Over 13 feet 0 inches and Up To and Including 18 feet 0 inches Wide: 6-5/8 inches outside diameter, Schedule 40 pipe or high strength steel pipe

4. Gate Leaves Over 18 feet 0 inches Wide: 8-5/8 inches outside diameter, Schedule 40 pipe or high strength steel pipe

D. Tension Wire: 7 gage galvanized or aluminum coated coil spring wire

2.2 CHAIN LINK FABRIC

A. The fabric shall consist of one piece fabric widths for fences up to 12 feet 0 inches - 2 inches mesh, 9 gage or 11 gage, as indicated on the drawings.

B. Selvage Edges: Fabric in heights 60 inches and less shall be knuckled at both selvages. Fabric 72 inches and more shall be knuckled at the bottom selvage and be twisted and barbed at the top.

C. Finishes: heavy galvanized, 2.0 ounces of zinc per square foot, complying with ASTM A392, Class II, or aluminum coated with 0.40 ounces of aluminum per square foot, complying with ASTM A491, Class II

2.3 ACCESSORIES

A. All accessories, except tie wires and barbed wire, shall be galvanized to comply with ASTM A153.

B. Barbed Wire Supporting Arms: heavy pressed steel, complete with provisions for anchorage to tubular end, corner, and pull posts attaching 3 rows of barbed wire to each arm. Barbed wire arms are not required on roll formed terminal posts. Single arms shall be integral with a post top weather cap. Intermediate arms shall have a hole for the passage of the top rail. Arms shall be capable of withstanding, without failure, 250 pounds downward pull at outermost end of arm.

C. Barbed Wire: 2 strand, 12-1/2 gage wire with 14 gage, 4 point round barbs spaced approximately 5 inches on center, with finishes as follows:

1. Galvanized: ASTM A121, Class 3

2. Aluminized: ASTM A585, Class 2

D. Post Tops: pressed steel or malleable iron (designed as a weathertight closure cap for tubular posts). Where top rail is used, provide tops to permit the passage of the top rail.

E. Stretcher Bars (for tubular end, corner, pull, or gate posts only): onepiece lengths equal to the full height of the fabric, with a minimum cross section of 3/16 inch by 3/4 inch. Provide one stretcher bar for each gate and end post and two for each corner and pull post.

F. Stretcher Bar Bands: heavy pressed steel spaced not over 15 inches on center to secure stretcher bars to tubular end, corner pull, and gate post

G. Wire Ties: For tying fabric to line posts, use 11 gage steel wire clips for C-section posts and a minimum 9 gage aluminum wire ties for tubular posts, spaced 14 inches on

center. For tying fabric to rails and braces use 9 gage aluminum wire ties spaced at inches on center. For tying fabric to tension wire use 11 gage hog rings spaced 24 inches on center.

2.4 GATES

A. Fabricate gate perimeter frames of 1.91 inches outside diameter tubular members galvanized in accordance with ASTM A120. Provide additional horizontal and vertical members to ensure proper gate operation and to allow for attachment of fabric, hardware, and accessories.

B. Assemble gate frames by welding or fittings and clamps for rigid connections. Use same fabric as for fence unless otherwise indicated. Install fabric with stretcher bars at vertical edges and top and bottom edges. Attach stretcher bars to gate frame at not more than 15 inches on center. Attach hardware with rivets or by other means that will provide security against removal or breakage.

C. Provide diagonal cross bracing that consists of 3/8 inch diameter adjustable length truss rods or gates where necessary to provide frame rigidity without sag or twist.

D. Gate Hardware: Provide the following hardware and accessories, with a heavy galvanized finish for each gate:

1. Hinges: pressed steel, or malleable iron to suit gate size, ball-bearing type, offset to permit 180 degree gate opening. Provide one pair of hinges for each leaf.

2. Latch: forked type or plunger bar type to permit operation from either side of the gate. Provide padlock eye as an integral part of the latch.

3. Keeper: Provide a keeper for each single gate that automatically engages the gate leaf and holds it in the open position until manually released.

4. Double Gates: Provide gate stops for all double gates consisting of concrete type as fence plate with anchors. Set in concrete to engage the center drop rod or plunger bar. Provide locking device and padlock eyes as an integral part of the latch, with one padlock for locking both gate leaves.

5. Sliding Gates: Provide the manufacturer's standard heavy duty track, ball bearing hanger sheaves, overhead framing and supports, guides, stops, locking and accessories as required.

PART 3. EXECUTION

3.1 The packing for all products shall be Level C.

3.2 SET ALL POSTS IN A 3,000 PSI CONCRETE FOOTING. Trowel smooth the top of each footing at a 20 degrees angle from the post to the surrounding ground so as to shed water away from the post. The post shall extend to the full depth of the footing. The diameter and depth of footings for various fence heights shall be as specified on the drawings.

3.3 All corner, terminal, and gate posts for fence 6 feet and higher shall have a midrail and 3/8 round adjustable truss rod to the next post.

3.4 All gates shall have a full wraparound hinge system with a positive latch with provision for a padlock. Gates 5 feet and under shall have a self-closing mechanism.

3.5 All fence shall have a bottom tension wire attached to the fabric and posts.

END OF SECTION

SECTION 02485

SEEDING

PART 1. GENERAL

1.1 This work shall be performed in all disturbed areas not receiving such site improvements as buildings, roads, walks, sod, planting, etc., and shall include, but not necessarily be limited to, all seed bed preparation; the supplying and placing of soil additives, seed, and mulch wherever required by the drawings or directed by the A/E; and maintenance.

1.2 Unless otherwise approved in writing by the A/E, seeding operations shall be limited to the following planting periods:

A. Between the dates of March 15 through October 15

1.3 Refer to other sections for items affecting seeding. Coordinate this work with that specified by other sections for timely execution.

PART 2. PRODUCTS

2.1 GRASS SEED: Seed shall meet the current specifications for the ODOT as to percentage purity, weed seed and germination. Seed mixture shall include:

A. 30 percent Kentucky Bluegrass (Poa pratensis)
B. 60 percent Kentucky 31 Fescue (Festuca arundinaci Var. Ky. 31)
C. 10 percent Perennial Ryegrass (Lolium perenne)

Seed shall be furnished in new bags or bags that are sound and not mended; no "below standard" seed accepted.

2.2 FERTILIZER: commercially manufactured; Grade 12-12-12; furnished in standard containers that are clearly marked with the name, weight, and guaranteed analysis of the contents and that ensure proper protection in transportation and handling; and in compliance with all local, state, and federal fertilizer laws

2.3 AGRICULTURAL LIMESTONE: containing a minimum of 85% calcium carbonate and magnesium carbonate combined, 85% of which passes a No. 10 mesh sieve

2.4 MULCH: stalks of rye, oats, wheat, or other approved grain crops properly cured prior to baling, air dried, and reasonably free of noxious weeds and weed seeds or other material detrimental to plant growth

PART 3. EXECUTION

3.1 Perform all seeding and related work as a continuous operation. Sow seed as soon as the seed bed has been prepared, and perform subsequent work in a continuous manner.

3.2 Before beginning seeding operations in any area, complete the placing of topsoil and final grading, and have the work approved by the A/E.

3.3 Scarify, disk, harrow, rake, or otherwise work each area to be seeded until the soil has been loosened and pulverized to a depth of not less than 2 inches. Perform this work only when the soil is in a tillable and workable condition.

3.4 Apply fertilizer and agricultural limestone uniformly over the seed bed, and lightly harrow, rake, or otherwise incorporate them into the soil for a depth of approximately 1 inch at the following rates:

Fertilizer: 15 pounds per 1,000 square feet
Agricultural Limestone: 40 pounds per 1,000 square feet

3.5 Sow seed uniformly with a rotary seeder, wheelbarrow seeder, or hydraulic equipment or by other satisfactory means.

3.6 The seeding rate shall be 5 pounds per 1,000 square feet for Kentucky 31 Fescue (Festuca Elatior).

3.7 When seeding during March 1 through April 1 and October 1 through November 20, add an additional 3 pounds per 1,000 square feet of annual rye grass.

3.8 Perform no seeding during windy weather or when the ground surface is frozen, wet, or otherwise untillable.

3.9 When seeding with mulch is specified, spread the mulch material evenly over the seeded areas immediately following the seeding operation.

Mulch Rate: 2 bales (100 pound minimum) per 1,000 square feet

3.10 The mulch rate may be varied by the A/E, depending on the texture and condition of the mulch material and the characteristics of the area seeded. Cover all portions of the seeded areas with a uniform layer of mulch so that approximately 25% of the ground is visible.

3.11 No equipment, material storage, construction traffic, etc., will be permitted on newly seeded ground.

3.12 Dispose of all surplus materials as directed by the Owner.

3.13 INSPECTIONS

A. The A/E shall inspect the seeding within 60 days after planting and determine if it is acceptable.

3.14 GUARANTEE

A. Secure an acceptable growth of grass in all areas designated for seeding.

B. An area is considered acceptable if it is represented by a minimum of 100 seedlings per square foot of the permanent species of grass representative of the seed mixture. If an acceptable growth is not obtained on the first planting, reseeding and remulching will be required.

C. If the planting is less than 50% successful, rework the ground, refertilize, reseed, and remulch.

END OF SECTION

SECTION 02513

PAVING

PART 1. GENERAL

1.1 The work specified by this section shall consist of furnishing all plant, labor, equipment, appliances, and materials and performing all operations in connection with the installation of pavement.

1.2 Both these specifications and the drawings make reference to the current edition of the standard specifications of the Ohio Department of Transportation (ODOT). Even though the weather limitations, construction methods, and materials specifications contained in the ODOT Specifications may not be explicitly repeated in these specifications, they shall, wherever applicable to the work called for by this section, be considered as implied and therefore adhered to. However, the various subsections "Basis for Payment" contained in the ODOT Specifications shall not be considered applicable.

1.3 Refer to other sections for items affecting paving.

PART 2. PRODUCTS

2.1 BITUMINOUS PRIME COATS: cutback asphalt, Grade RC-250, or material emulsified asphalt.

2.2 DOUBLE BITUMINOUS SURFACE: for both courses, either cutback asphalt, Grade RC-800 or RC-3000, or emulsified asphalt, Grade RS-2

PART 3. EXECUTION

3.1 SUBGRADE

A. Before any base material is installed, compact the subgrade of the area to be paved to 95% of optimum density as determined by ASTM D698 (Standard Proctor).

B. The joint between new and existing pavement shall be true and approximately at right angles to the centerline of the existing pavement. When a base course is compacted, cut back the surface course of the existing pavement a minimum of 1 foot beyond the limit of the joint between the old and new base course. Take special care to ensure good compaction of the new base course at the joint. Apply and compact the surface to conform to the existing pavement so that it will have no surface irregularity.

3.2 DOUBLE BITUMINOUS SURFACE

A. Apply the first course at a rate of 0.38 to 0.42 gallon per square yard with either emulsified asphalt, Grade RS-2, or cutback asphalt, Grade RC-800 or RC-3000, and then immediately cover with Size 6 crushed stone chips at a rate of 33 to 37 pounds per square yard. After this is rolled, apply the second course at a rate of 0.30 to 0.35 gallon per square yard, and at once uniformly cover with Size 7 chips at a rate of 20 to 25 pounds per square yard. Then roll the entire area.

B. After the application of the cover aggregate, lightly broom or otherwise maintain the surface for a period of 4 days, or as directed by the A/E. Maintenance of the surface shall include the distribution of cover aggregate over the surface to absorb any free bitumen and cover any areas deficient in aggregate. Sweep excess material from the entire surface with rotary brooms. Sweep the surface at the time determined by the A/E.

3.3 SAMPLING AND TESTING

A. Submit to the A/E test reports made by an independent testing laboratory on the crushed mineral aggregate, bituminous materials, and asphaltic concrete design mixes, and obtain his approval of these reports before starting paving operations.

END OF SECTION

SECTION 02721

STORM DRAINAGE

PART 1. GENERAL

1.1 The work covered by this section shall consist of excavating and backfilling the trench and of furnishing, laying, and jointing corrugated metal culvert pipe and fittings. Excavation for storm drains shall comply with all applicable provisions of Section 02221, Unclassified Excavation for Utilities.

PART 2. PRODUCTS

2.1 CORRUGATED METAL CULVERT PIPE

A. Corrugated metal culvert pipe shall conform to the requirements of AASHTO M36 specifications for corrugated metal culvert pipe. The gauges for various sizes of pipe shall be as follows unless otherwise noted on the plans:

DIAMETER	GAUGES (2 2/3 INCH x 1/2 INCH CORRUGATION)
15 inches	16
18 inches	16
24 inches	16
30 inches	14
36 inches	14
42 inches	12
17 inch x 13 inch pipe arch	14
21 inch x 15 inch pipe arch	14
28 inch x 20 inch pipe arch	14
35 inch x 24 inch pipe arch	14
42 inch x 29 inch pipe arch	14
49 inch x 33 inch pipe arch	12
57 inch x 38 inch pipe arch	12

B. The Contractor shall require that his supplier furnish a certification that all materials furnished meet the above standards and specifications.

C. Furnish pipe in the sizes shown on the drawings.

2.2 JOINT MATERIALS

A. Joints for each sewer pipe larger than 15 inches in internal diameter shall be rubber gasketed.

PART 3. EXECUTION

3.1 PIPELINE CONSTRUCTION

A. Lay no pipe except in the presence of an inspector representing the A/E.

B. Before constructing or placing joints, demonstrate to the A/E, by completing at least one sample joint, that the methods employed conform to the specifications and will provide a watertight joint, and further that the workmen intended for use on this phase of the work are thoroughly familiar and experienced with the type of joint proposed.

C. Before placing drainage pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting as provided in Section 02221, Unclassified Excavation for Utilities.

D. Wherever necessary to provide a satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by the A/E. Cradles shall be of concrete with f' = 3,000 psi, as defined by ACI standards, and shall conform to the dimensions shown on the detailed drawings.

E. Tightly stretch a mason's line or wire above the ground level, parallel to and directly above the axis of the pipe to be installed; this line is to be supported at intervals of no more than 50 feet on sewers being laid on a grade of 2% or more and not exceeding 25 feet for grades of less than 2%. Determine the exact line and grade for each section of pipe by measuring down from this line to the invert of the pipe in place. Accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batterboards. The use of laser beams will be allowed.

F. Do not allow water to run or stand in the trench while pipe laying is in progress, before the joint has completely set, or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.

G. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have been started, and bring them to exact line and grade with compacted earth as necessary.

H. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade.

3.2 CLEAN-UP

A. After completing each section of sewer line, remove all debris and construction materials and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

END OF SECTION

SECTION 02722

HIGH DENSITY POLYETHYLENE PIPE

PART 1. GENERAL

1.1 The proposed plant effluent pipe shall be high density polyethylene pipe, as manufactured by Plexco, Poly Pipe Industries, or "Driscopipe" as manufactured by Phillips Product Co., Inc., or equal.

PART 2. PRODUCTS

2.1 MATERIALS FOR POLYETHYLENE PIPE

A. The polyethylene pipe and fittings shall be made of polyethylene resins classified in ASTM D 1248-72 as Type III, Category 5, Grade P34 (pipe designation PE 3408 defined per ASTM D 3350-84), having specific base resin densities of 0.942 g/cc minimum and 0.955 g/cc maximum, respectively; and having melt indexes at condition E of 0.4 g/10 min. maximum and 0.10 g/0.10 min. minimum, respectively.

B. Pipe made from those resins must have a long-term strength rating of 1,600 psi or more.

C. The polyethylene resin shall contain antioxidants and shall be stabilized with carbon black against ultra-violet degradation to provide protection during processing and subsequent weather exposure.

D. The polyethylene resin compound shall have a resistance to environmental stress cracking as determined by the procedure detailed in ASTM D 1693-70, Condition B with sample preparation by procedure C of not less than 200 hours.

2.2 POLYETHYLENE PIPE AND FITTINGS

A. The inside diameter of polyethylene pipe furnished and installed under this Contract shall be not less than the inside diameter shown on the Drawings.

B. Polyethylene pipe furnished and installed under the Contract shall be designed for the pipe pressure rating indicated on the drawings. The wall thickness of the pipe shall not be less than that required to meet the standard dimension ratio, SDR, indicated on the drawings.

C. All pipe shall be made from virgin material. No rework compound.

D. Pipe shall be homogenous throughout, and be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.

E. Fittings for the polyethylene pipe line shall be molded or fabricated from the same material as specified hereinbefore for the high density polyethylene pipe. Extrusion welding and hot gas welding are not permitted.

F. Fittings shall be provided for all bends 22-1/2 degrees or greater and as otherwise indicated on the drawings. For alignment changes of less than 20 degrees deflection, the pipe may be laid in curves with a radius of 100 feet or greater.

G. All run-of-the-pipe fittings shall be fusion welded into the pipe line. Tee branches shall be of the size shown on the Drawings and shall be furnished with flanged ends per ANSI B-16.1. All fittings shall be factory made.

H. Fittings shall be capable of withstanding the same pressure and loading conditions specified for the pipe.

I. Wye branches shall be true wyes.

2.3 PIPE JOINTING

A. Pipe to be joined by leakproof, thermal, butt fusion joints. All fusion must be done by personnel trained by the pipe supplier using tools approved by the pipe supplier.

B. The fusion machine shall have hydraulic pressure control for fusing 2 pipe ends together. The machines shall be equipped with an electric or gasoline engine powered facing unit to trim irregularities from the pipe ends. The heating plate on the fusion machine shall be electrically heated and thermostatically controlled and shall contain a temperature gauge for monitoring temperature.

C. Joint strength must be equal to that of adjacent pipe as demonstrated by tensile test. In addition, results of tensile impact testing of joint should indicate a ductile rather than a brittle fracture. External appearance of fusion bead should be smooth without significant juncture groove.

D. Threaded or solvent cement joints and connections are not permitted.

2.4 JOINING, TERMINATING OR ADAPTING BY MECHANICAL MEANS

A. The polyethylene pipe shall be connected to systems or fittings of other materials by means of an assembly consisting of a polyethylene flange adapter butt-fused to the pipe, a backup ring of either cast iron, steel, or high silica aluminum alloy made to ANSI B-16.1 dimensional

standards (with modified pressure ratings), bolts of compatible material (insulated from the fittings where necessary) and a gasket of reinforced black rubber, asbestos-rubber compound or other material approved by the Engineer, cut to fit the joint. In all cases, the bolts shall be drawn up evenly and in line.

B. Termination of valves, or fittings such as tees, bonds, etc., made of other materials shall be by the flange assemblies specified hereinbefore. The pipe adjacent to these joints and to joints themselves must be rigidly supported for a distance of one pipe diameter or 1 foot, whichever is greater, beyond the flange assembly.

C. Appurtenances must be placed on their own foundations, unsupported by the pipe, in accordance with the detail plans.

2.5 TOOLS AND PROCEDURES

A. Fusion jointing and other procedures necessary for correct assembly of the polyethylene pipe and fitting will be done only by personnel trained in those skills by the pipe supplier.

B. Only those tools designed for aforementioned procedures and approved by the pipe supplier shall be used for assembly of pipe and fittings to insure proper installation.

PART 3. EXECUTION

3.1 INSTALLING HIGH DENSITY POLYETHYLENE PIPE

A. General:

1. High density polyethylene pipe shall be installed in strict accordance with the manufacturer's recommendations and these Specifications.

2. The Contractor shall have the manufacturer furnish all necessary technical assistance, installation instruction and jointing supervision required to insure that the pipe is properly installed. The Contractor shall furnish the services of a technical representative of the manufacturer to supervise the joining, bedding, laying and backfilling of the pipe.

3. The manufacturer's technical representative shall have had previous experience with similar work, and be fully qualified to supervise and demonstrate proper procedures for jointing and laying the high density polyethylene pipe.

B. Grade and Alignment:

1. Polyethylene pipe shall be laid to predetermined grades and lines as indicated by the Contract Drawings. Grade lines shall be established either by means of offset stakes or by direct levels.

3.2 TESTING POLYETHYLENE PIPE

A. The Contractor shall hydrostatically test polyethylene pipe prior to placing the pipe in service. The test pressure shall be the rated operating pressure of the pipe or the lowest rated component in the system.

B. The Contractor shall place the pipe in the trench and shall secure the pipe prior to testing.

C. The pipeline shall be filled with water taking care to bleed off trapped air. The initial pressure test shall be applied and allowed to stand without makeup pressure for a sufficient time for diametric expansion or pipe stretching to stabilize. After the equilibrium period, the test pressure shall be applied and maintained for three hours. Allowable makeup water shall not exceed PPI Technical Report TR31/9-79 allowance for expansion under test pressure.

D. While the test pressure is on, each joint shall be tested for bubbling air with soap suds brushed on to form a solid film around the joint. (10)

E. In the event leakage is detected or excessive makeup water is required, the Contractor shall repair the pipe and retest.

F. The Contractor shall furnish all necessary labor, materials and equipment required for testing, including but not limited to pipe adaptors, fittings, pumps, gages and water.

END OF SECTION

SECTION 03301

CONCRETE WORK

PART 1. GENERAL

1.1 EXTENT OF THE WORK

A. The extent of concrete work is shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI 301, Specifications for Structural Concrete for Buildings

2. ACI 302, Guide for Concrete Floor and Slab Placement

3. ACI 304, Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete

4. ACI 305, Hot Weather Concreting

5. ACI 306, Cold Weather Concreting

6. ACI 315, Detailing Manual

7. ACI 318, Building Code Requirements for Reinforced Concrete

8. ACI 347, Recommended Practice for Concrete Formwork

9. CRSI Manual of Standard Practice

B. The Contractor is responsible for correcting concrete work that does not conform to the specified requirements, including requirements for strength, tolerances, and finishes. Correct deficient concrete as directed by the A/E.

C. Employ at the Contractor's expense a testing laboratory acceptable to the A/E to perform material evaluation tests and to design and review concrete mixes.

D. Materials and installed work may require testing and retesting, as directed by the A/E, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. Tests not

specifically indicated to be done at the Owner's expense, including the retesting of rejected materials and installed work, shall be done at the Contractor's expense.

E. Test aggregates by the methods of sampling and testing outlined in ASTM C33.

F. For portland cement, sample the cement and determine the properties by the methods of testing outlined in ASTM C150.

1.3 SUBMITTALS

A. Comply with applicable requirements of Section 01302, Submittals and Substitutions.

B. For each material sampled and tested, submit written reports to the A/E prior to the start of work. Provide the project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, materials manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for the intended use.

C. Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing and sealing compounds, and others requested by the A/E.

D. Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with the ACI 315, Detailing Manual, showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Show on the shop drawings special reinforcement required and openings through concrete structures.

E. Submit 2 copies of laboratory test reports with standard deviation analysis or trial batch data. All concrete materials shall be listed.

PART 2. PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Unless otherwise specified or shown on the Drawings, construct formwork for exposed concrete surfaces with plywood, metal, metal framed plywood, or other panel type materials acceptable to the A/E in order to provide exposed surfaces that are

continuous, straight, and smooth. To minimize the number of joints and to conform to the joint system shown on the Drawings, furnish panels in the largest practicable sizes. Provide form material that is thick enough to withstand pressure of newly placed concrete without bowing or deflection.

B. Forms for Unexposed Finish Concrete: For surfaces that will be unexposed in the finished structure, form concrete with plywood, lumber, metal, or other material acceptable to the A/E. If lumber is used, it shall be dressed on at least two edges and one side for tight fit.

C. Form Coatings: Provide commercial formulation form coating compounds that will not bond with, stain, or adversely affect concrete surface and that will not impair subsequent treatments of concrete surfaces to be cured with water or curing compound.

2.2 REINFORCING MATERIALS

A. Reinforcing Bar: ASTM A615, Grade 60

B. Supports for Reinforcement: Provide supports for reinforcement, including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Unless otherwise indicated on the Drawings, use wire type bar supports complying with CRSI recommendations. Wood, brick, and other devices will not be acceptable. Comply with the following:

1. For slabs on grade, where wetted base material will not support chair legs, use supports with sand plates or horizontal runners.

2. For concrete surfaces exposed to view, where leg supports are in contact with forms, provide supports with legs that are hot dip galvanized or protected by either plastic or stainless steel.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C150, Type I. Use only one brand of cement throughout the project, unless otherwise acceptable to the A/E.

B. Normal Weight Aggregates: ASTM C33, and as specified below:

1. Local aggregates that do not comply with ASTM C33 but that have been shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the A/E.

2. Fine aggregate is to be clean, sharp, river sand or crushed gravel when used for vehicular wearing surfaces. Manufactured sand may be used elsewhere provided the percentage passing a No. 200 sieve is less than 3 percent.

C. Coarse Aggregate: Coarse aggregate shall consist of crushed stone that is clean, uncoated, and processed from natural rock or stone and that contains no clay, mud, loam, or foreign matter. Its maximum size shall be no larger than 1/5 of the narrowest dimension between sides of forms, 1/3 of the depth of slabs, or 3/4 of the minimum clear spacing between individual reinforcing bars or bundles of bars.

D. Water: clean, fresh, drinkable

E. Admixtures

1. Water Reducing Admixture: Eucon WR-75 by the Euclid Chemical Company, Pozzolith 200N by Master Builders, or Plastocrete 160 by Sika Chemical Corporation. The admixture shall conform to ASTM C494, Type A, and not contain more chloride ions than are present in municipal drinking water.

2. Water Reducing, Retarding Admixture: Eucon Retarder-75 by the Euclid Chemical Company, Pozzolith 100 XR by Master Builders, or Plastiment by Sika Chemical Corporation. The admixture shall conform to ASTM C494, Type D, and not contain more chloride ions than are present in municipal drinking water.

3. High Range Water Reducing Admixture (Superplasticizer): Eucon 37 by the Euclid Chemical Company or Sikament by Sika Chemical Corporation. The admixture shall conform to ASTM C494, Type F or G, and not contain more chloride ions than are present in municipal drinking water.

4. Nonchloride Accelerator: Accelguard 80 by the Euclid Chemical Company or Darex Set Accelerator by W. R. Grace. The admixture shall conform to ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water.

5. Air Entraining Admixture: ASTM C260

6. Calcium Chloride: Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.

7. Pozzolanic Admixtures: ASTM C618

8. Certification: Written conformance to the abovementioned requirements and the chloride ion content will be required from the admixture manufacturer prior to mix design review by the A/E.

2.4 MIX DESIGN

A. Preparation

1. Prepare design mixes for each type and strength of concrete in accordance with applicable provisions of ASTM C94. Use an independent testing facility acceptable to the A/E for preparing and reporting proposed mix designs. The testing facility shall not be the same one used for field quality control testing unless this is acceptable to the A/E. Submit to the A/E written reports of each proposed mix for each class of concrete at least 15 days before the start of work. Do not begin concrete production until the A/E reviews the mixes.

2. The design mix shall provide normal weight concrete with 4,000 psi, 28 day compressive strength.

B. Adjustment to Concrete Mixes: The Contractor may request adjustments to the mix design when warranted by the characteristics of the materials, job conditions, weather, test results, or similar circumstances. Such adjustments shall be made only if approved by the A/E and at no additional cost to the Owner. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the A/E before the revised mix design is used in the work.

C. Admixtures

1. All concrete shall contain the specified water reducing admixture and/or high range water reducing admixture (superplasticizer). All concrete slabs placed at air temperatures below 50 degrees F shall contain the specified nonchloride accelerator. All concrete required to be air entrained shall contain an approved air entraining admixture. All pumped concrete, architectural concrete, concrete for industrial slabs and parking decks, and concrete with a water/cement ratio below 0.50 shall contain the specified high range water reducing admixture (superplasticizer).

a. Use an air entraining admixture in all concrete structures and slabs exposed to freezing and thawing or subjected to hydraulic pressure:

2.5 percent to 5.5 percent for maximum 2 inches aggregate
4.5 percent to 7.5 percent for maximum 3/4 inch aggregate
5.5 percent to 8.5 percent for maximum 1/2 inch aggregate

2. Water/Cement Ratio: All concrete exposed to freezing and thawing shall have a maximum water/cement ratio of 0.50. All concrete subjected to deicers and/or required to be watertight shall have a maximum water/cement ratio of 0.45.

3. Use the amounts of admixtures recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

D. Slump Limits

1. All concrete containing the high range water reducing admixture (superplasticizer) shall have a maximum slump of 8 inches unless otherwise approved by the A/E. The concrete shall arrive at the job site at a slump of 2 inches to 3 inches and be verified; then the high range water reducing admixture shall be added to increase the slump to the approved level.

2. All other concrete shall have a maximum slump of 3 inches for slabs and 4 inches for other members.

2.5 PROPORTIONING

A. Ready Mix Concrete

1. Comply with the requirements of ASTM C94 and of these specifications.

2. During hot weather or under conditions that contribute to rapid setting of concrete, a shorter mixing time than that specified in ASTM C94 may be required. When the air temperature is between 85 degrees and 90 degrees F, reduce the mixing and delivery time from 1-1/2 hours to 75 minutes; when the air temperature is above 90 degrees F, reduce the mixing time to 60 minutes.

3. Each load of concrete arriving at the job shall be accompanied by a delivery ticket that shall be collected by the Contractor and submitted to the A/E and shall contain the following information:

a. The design mix and strength of mix of concrete being delivered

b. The exact time the cement, aggregate, and water were discharged into the delivery truck

PART 3. EXECUTION

3.1 FORMS

A. Design, erect, support, brace, and maintain formwork to support any vertical and lateral loads that may be applied until such loads can be supported by the concrete structure. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position.

B. Design formwork so that it can be readily removed without impact, shock, or damage to cast in place concrete surfaces and adjacent materials.

C. Construct forms complying with ACI 347 to the sizes, shapes, lines, and dimensions shown on the Drawings so that in the finished structures the work will be level and plumb and have accurate alignment, location, and grade. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features that the work requires. Use selected materials to obtain the required finishes. Butt joints solidly, and provide backup at joints to prevent leakage of cement paste.

D. Fabricate forms so that they can be easily removed without hammering or prying against the concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep for the concrete to be placed with bottom forms only. To form keyways, reglets, recesses, and the like, kerf wood inserts to prevent swelling and to permit easy removal.

E. Where the interior area of formwork is not accessible for cleanout, provide temporary openings to permit concrete placement and inspection before the concrete is placed. Brace temporary openings securely and set them tightly to forms to prevent the loss of concrete mortar. Position temporary openings on forms at inconspicuous locations.

F. Use metal form ties that are factory made, adjustable in length, designed to prevent form deflection, and either removable or snap-off and that will prevent the concrete surface's being spalled when the ties are removed. If snap-off ties are used, the portion remaining within the concrete after removal must be at least 1-1/2 inches inside the concrete unless the Drawings indicate otherwise.

G. Unless the Drawings indicate otherwise, provide form ties that will not leave holes larger than 1-1/2 inches in diameter in the concrete surface.

H. Provide openings in concrete formwork to accommodate the work of other trades. Determine the size and location of openings, recesses, and chases from the trades providing such work. Accurately place and securely support items built into forms.

I. Clean thoroughly forms and adjacent surfaces that are to receive concrete. Remove chips, wood, sawdust, dirt, and any other debris just before the concrete is placed. After concrete placement, retighten forms if necessary to eliminate mortar leaks.

3.2 PLACING REINFORCEMENT

A. For details and methods of placing reinforcement and supports, comply with the specified codes and standards, the recommended practice of the CRSI as outlined in "Placing Reinforcing Bars," and these specifications.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials that reduce or destroy the bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement with metal chairs, runners, bolsters, spacers, and hangers as required for security.

D. Place reinforcement to obtain at least the minimum coverages for concrete protection as required by ACI 318. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so that ends are directed into the concrete, not toward exposed concrete surfaces.

E. Do not place reinforcing bars more than 2 inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment or similar construction loads.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into the work anchoring devices and other embedded items required for other work that are to be attached to or supported by cast in place concrete. Use setting drawings, diagrams, instructions, and directions provided by the suppliers of the items to be attached thereto.

3.4 PREPARATION OF FORM SURFACES

A. Before placing reinforcement, coat the contact surfaces of forms with a form coating compound.

B. Thin the form coating compound only with the amount and type of thinning agent and only under the conditions recommended by the compound manufacturer. Do not allow excess form coating material to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply the form coating compound in compliance with the manufacturer's instructions.

C. Coat steel forms with a nonstaining, rust preventive form oil, or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades that the formwork is complete so that they may then install their work; cooperate with other trades in setting such work. Wherever form coatings are not used, wet wood thoroughly just before placing concrete.

B. Deposit concrete either continuously or in layers thick enough to prevent its being placed on concrete that has hardened enough to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as close to its final location as practicable in order to avoid segregation due to rehandling or flowing.

C. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner that avoids inclined construction joints. Where placement consists of several layers, avoid cold joints by placing each layer while the preceding one is still plastic.

D. Use mechanical vibrating equipment supplemented by hand spading, rodding, or tamping to consolidate placed concrete. The equipment and procedures used to consolidate the concrete shall comply with the recommended practices of ACI 309 and suit both the type of concrete and project conditions.

E. Do not use vibrators to transport concrete once it is inside the forms. Insert and withdraw vibrators vertically at uniformly spaced locations no further apart than the visible horizontal effectiveness of the machine. Limit layer heights so that the vibrator is effective into 6 inches of the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete, and complete embedment of reinforcement and other embedded items without causing segregation of the mix. Lower frequency vibrators may be used with "flowing" concrete.

F. Consolidate concrete during placing operations so that it is thoroughly worked around reinforcement and other embedded items and into corners.

G. Maintain reinforcement in the proper position during placement operations.

H. Cold Weather Placement

1. Comply with ACI 306 and the requirements herein specified to protect concrete work from physical damage or reduced strength due to frost, freezing, or low temperatures.

2. When the air temperature has fallen or is expected to fall below 40 degrees F, heat all water and aggregates uniformly before mixing so that the concrete, at point of placement, will have a temperature of not less than 50 degrees nor more than 80 degrees F.

3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

4. Use only the specified nonchloride accelerator. Do not use calcium chloride or admixtures containing more than 0.1 percent chloride ions.

I. Hot Weather Placement

1. When the weather is hot enough to impair seriously the concrete's quality and strength, place the concrete as specified herein and in ACI 305.

2. Cool ingredients before mixing so that when the concrete is placed, its temperature is below 90 degrees F. Mixing water may be chilled, or else a portion of the water may be in the form of chopped ice.

3. If reinforcing steel becomes hotter than the ambient air temperature, cool it with water soaked burlap so that its temperature will not exceed the ambient air temperature.

4. When high temperatures and/or placing or humidity conditions dictate, the mix may be initially retarded by use of the water reducing, retarding formulation (Type D) of the specified water reducing admixture (Type A).

3.6 FINISH OF FORMED SURFACES

A. Rough Form Finishes: For formed concrete surfaces not exposed to view in the finished work or covered by other construction, use a rough form finish unless otherwise indicated by the Drawings. Repair and patch tie holes and defective areas, and rub down or chip off fins and other projections more than 1/4 inch high.

3.7 CURING

A. After placing and finishing the concrete, start initial curing as soon as free water has disappeared from concrete surface. Keep continuously moist for not less than 7 days.

B. Begin final curing immediately after initial curing and before the concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301. Avoid rapid drying at the end of the final curing period.

C. Cure concrete by moist curing, moisture retaining cover curing, membrane curing, or combinations of these methods, as specified herein.

D. Provide moisture curing by one of the following methods:

1. Keep concrete surface continuously wet by covering with water.

2. Spray it continously with a water fog.

3. Cover the concrete surface with the specified absorptive cover, thoroughly saturating the cover with water and keeping it wet; position the absorptive cover so that it covers the concrete surface and edges and laps adjacent absorptive covers by 4 inches.

E. Provide moisture cover curing by covering concrete surfaces with a moisture retaining cover designed for curing concrete. Place the cover in the widest practicable width of material with sides and ends of the material lapped at least 3 inches and sealed by waterproof tape or adhesive.

Repair immediately any holes or tears that occur during the curing period with identical cover material and waterproof tape.

3.8 REMOVAL AND REUSE OF FORMS

A. Formwork not supporting weight of concrete (e.g., sides of walls and similar parts of the work) may be removed after curing at a temperature of not less than 50 degrees F 24 hours after the concrete is placed, provided the concrete is hard enough not to be damaged by form removal operations and provided curing and protection operations are maintained.

B. Form facing material may be removed 4 days after concrete placement only if shores and other vertical supports have been arranged to permit it to be removed without loosening or disturbing shores and supports.

3.9 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Unless the Drawings show otherwise or the A/E directs, fill in holes and openings left in concrete structures for the work of other trades once that work is in place. Mix, place, and cure concrete as specified herein to blend with in-place construction. Provide other miscellaneous concrete filling shown on the Drawings or necessary to complete the work.

3.10 CONCRETE SURFACE REPAIRS

A. Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to the A/E.

B. Cut out honeycomb, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete, but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Before placing cement mortar, thoroughly clean, dampen with water, and apply the specified bonding compound. The cement mortar shall be placed after the bonding compound has dried.

C. Where possible, repair concealed formed surfaces that contain defects which adversely affect the durability of the concrete. If such defects cannot be repaired, remove and replace the concrete.

D. Repair defective areas (except for random cracks and single holes not more than 1 inch in diameter) by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4 inch clearance all

around. Dampen concrete surfaces in contact with patching concrete, and apply the specified bonding compound. Place patching concrete after the bonding compound has dried. Mix patching concrete of the same materials to provide concrete of the same type or class as the original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

E. Repair isolated random cracks and single holes not over 1 inch in diameter by the dry pack method. Groove top of cracks, cut out holes until sound concrete is reached, and clean to remove dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply the specified bonding compound. Place dry pack after the bonding compound has dried. Dry pack shall consist of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve. Mix with no more water than is necessary for handling and placing. Compact dry pack mixture in place, and finish to match adjacent concrete. Keep patched area continuously moist for no less than 72 hours.

F. All structural repairs shall be made, with prior approval of the A/E as to the method and procedure, using the specified epoxy adhesive and/or epoxy mortar.

G. Repair methods not specified above may be used, subject to acceptance by the A/E.

3.11 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Contractor shall employ a testing laboratory to perform any or all of the tests specified below and to submit reports on these tests. Sampling and testing for quality control during the placement of concrete may include the following, as directed by the A/E:

1. Sampling Fresh Concrete: ASTM C172, but modified for slump to comply with ASTM C94

2. Slump: ASTM C143; one test for each concrete load at point of discharge and one test of each set of compressive strength test specimens

3. Air Content: ASTM C173 volumetric method for lightweight concrete; ASTM C231 pressure method for normal weight concrete; one test for each set of compressive strength test specimens

4. Concrete Temperature: Test hourly when air temperature is 40 degrees F and below or when 80 degrees F and above and each time a set of compression test specimens is made.

5. Compression Test Specimen: ASTM C31; one set of 6 standard cylinders for each compressive strength test, unless otherwise directed by the A/E. Mold and store cylinders of laboratory cured test specimens except when the A/E requires field cured test specimens.

6. Compressive Strength Tests: ASTM C39; one set for each 100 cubic yards or fraction thereof of each concrete class placed in any one day or one set for each 5,000 square feet of surface area placed; 2 specimens tested at 7 days, 3 specimens tested at 28 days, and 1 specimen retained in reserve for later testing, if needed (11)

B. When the total quantity of a given class of concrete is less than 50 cubic yards, the strength test may be waived by the A/E if, in his judgment, adequate evidence of satisfactory strength is provided.

C. The strength level shall be considered satisfactory as long as the averages of all sets of 3 consecutive strength test results equal or exceed the specified strength f'c, and no individual test result falls below the specified strength f'c by more than 500 psi.

D. When the strength of field cured cylinders is less than 85 percent of companion laboratory cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

E. Test results will be reported to the A/E and Contractor in writing on the same day that the test is made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials, and compressive breaking strength and type of break for both 7 day tests and 28 day tests.

F. The testing service will make additional tests of in-place concrete when the test results indicate that the required strength level has not been achieved and other characteristics have not been attained in the structure, as directed by the A/E. The testing service may conduct tests to determine the adequacy of concrete by cored cylinders that comply with ASTM C42 or by such other methods as are directed by the A/E. The Contractor shall pay for such tests and any additional testing that may be required when concrete is verified to be unacceptable.

END OF SECTION

APPENDIX C

DESIGN PACKAGE 3

INSTALLATION RESTORATION PROGRAM

ENVIRONMENTAL INVESTIGATION OF GROUND WATER CONTAMINATION AT WRIGHT-PATTERSON AIR FORCE BASE, OHIO

DESIGN PACKAGE 3
GROUND WATER EXTRACTION WELLS

Submitted by:

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MAY 21, 1991
(REVISED JANUARY 1992)

ACRONYMS

CFR	Code of Federal Regulations
CW	Cluster Well
EW	Extraction Well
FP	Field Procedure
FS	Feasibility Study
gpm	Gallons per Minute
IRP	Installation Restoration Program
OEPA	Ohio Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
VOCs	Volatile Organic Compounds
WPAFB	Wright-Patterson Air Force Base

CONTENTS

FIGURES

1.0 INTRODUCTION

This Design Package was prepared for the implementation of the Phase II removal action at Wright-Patterson Air Force Base (WPAFB) in Dayton, Ohio. The objective of the removal action is to prevent, to the extent practicable, the migration of contaminated ground water across the Base boundaries. This removal action was initiated through the Installation Restoration Program (IRP) in accordance with Administrative Orders on Consent issued to WPAFB from the Ohio Environmental Protection Agency (OEPA), and will include the installation of one to three ground water extraction wells, each producing 300 to 800 gpm.

2.0 WELL LOCATIONS

The first extraction well (EW-1) will be located near monitoring well cluster CW5 (Figure 2.1). It is estimated that additional extraction wells may be located near CW6 and approximately 500 feet south of EW-1. The exact locations extraction wells EW-2 and EW-3 will be determined based on information collected and analyzed after startup of the extraction system. For well installation purposes, it is estimated that the time from system startup to the start of installation of subsequent wells will be 4 to 6 weeks.

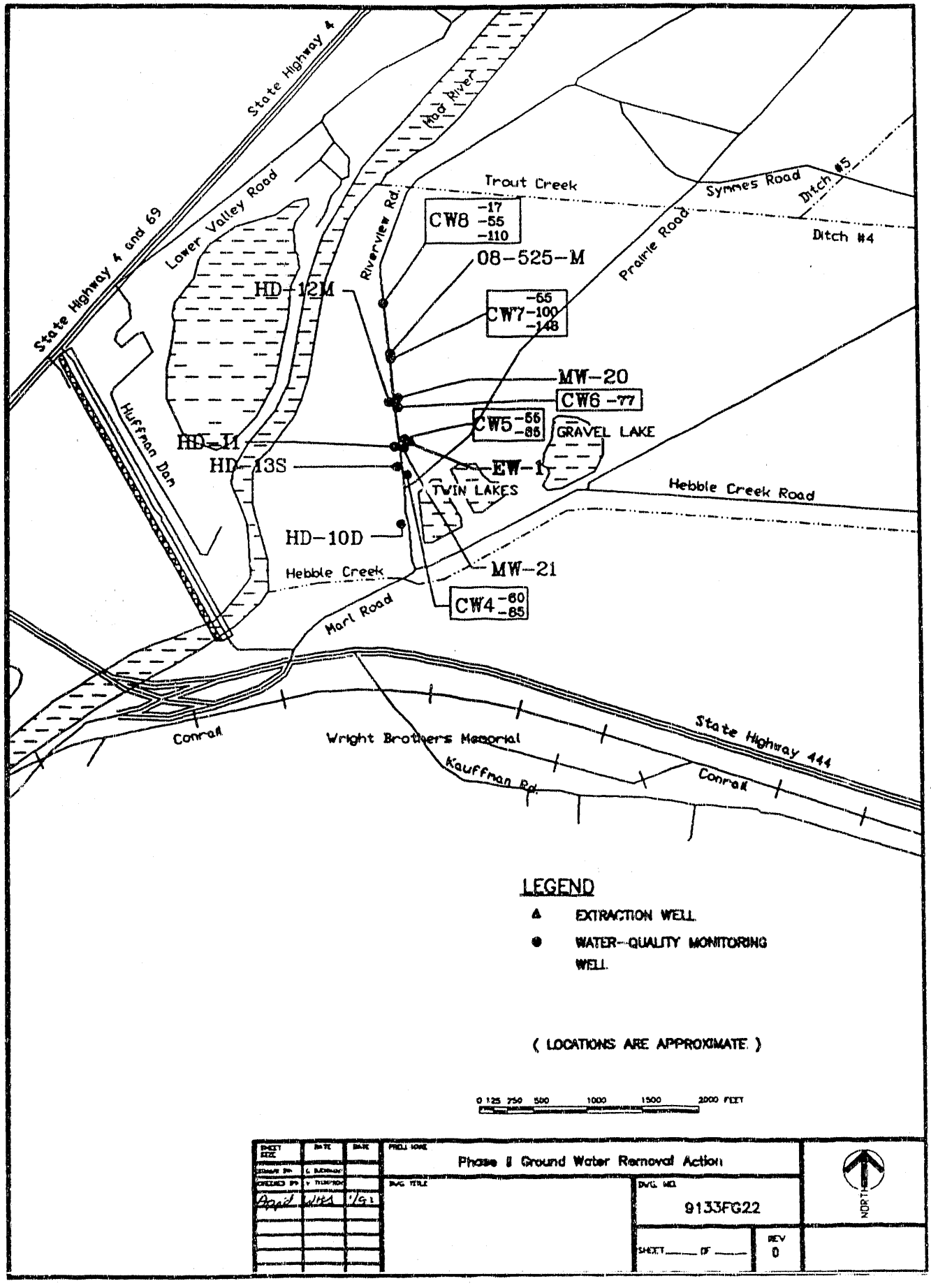


FIGURE 2.1. Location of Extraction Well EW-1

3.0 GENERAL CONDITIONS

The information below is summarized from the Phase II Work Plan and Health and Safety Plan, which are included in these specifications by reference. The site is accessible by conventional vehicles and on paved roadways. All vehicles will be required to enter and exit at WPAFB Gate 15A.

3.1 MATERIAL HANDLING, DELIVERY, AND STORAGE

An onsite material staging area will be provided. All material and equipment not in use at the drilling location will be maintained and protected from the elements at this location. If filter pack materials (sand or small gravel) are purchased in bulk, they will be stored on plastic sheeting and covered for protection. The staging area will be maintained in an orderly manner at all times.

All material cuttings generated from soil borings will be containerized at the drilling locations and transported to the staging area for storage. Water and sediment generated during well development will also be containerized and stored for disposal by others, in accordance with procedures for project-generated waste in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan.

3.2 CERTIFICATIONS AND PERMITS

The drilling contractor will be licensed and certified by the State of Ohio as a water well contractor. Additionally, all personnel working onsite will have completed the Occupational Safety and Health Administration (OSHA) 40-hour safety training for work at uncontrolled hazardous waste sites and currently be part of a medical monitoring program that meets the requirements of 29 Code of Federal Regulations (CFR) 1910.120. Copies of license, training certificates, and proof of medical monitoring will be furnished by the contractor if requested.

3.3 HEALTH AND SAFETY

While some contaminants may be encountered during onsite work, it is believed that all work will be performed under Level "D" as described in the Phase II Health and Safety Plan.

3.4 EQUIPMENT DECONTAMINATION

All drilling equipment, such as drill rig bits, bailer, downhole equipment, and drive casing, including well screen and riser pipe, will be decontaminated prior to drilling or well installation. All downhole and drilling equipment will also be decontaminated before leaving the site. After final decontamination of downhole equipment, a rinsate sample will be obtained from the downhole equipment and analyzed to ensure proper cleaning. The decontamination area and pad will be provided.

Decontamination procedures will follow those outlined in the RI/FS Quality Assurance Project Plan (QAPP) Section 8.0 and are as follows:

- Cleaning with high-pressure steam or hot water cleaner.
- Washing with potable water and a nonphosphate laboratory-grade detergent.
- Rinsing with potable water.

4.0 DRILLING AND WELL CONSTRUCTION

Procedures presented below conform to those presented in the RI/FS QAPP Field Standard Operating Procedures (FP), as applicable, which are incorporated herein by reference.

4.1 TEST BORING

A test boring will be advanced to the top of bedrock at extraction well locations. Borings will be sampled using a 2-foot, split-barrel sampler, with samples obtained at 5-foot intervals to the water table (FP 5-1). After encountering ground water, sampling will be continuous to the top of bedrock. Each sample will be logged by an engineer/geologist (provided by others) at the time of collection. One sample from each stratigraphic horizon encountered will be submitted for grain-size distribution analyses (FP 6-6). This information will be used to determine the appropriate gravel pack and screen size. All samples will be placed in appropriate containers and retained for future reference for up to 6 months as a supplement to the boring log and grain-size analyses. All cuttings from the boring will be handled as outlined in Section 3.1

4.2 EXTRACTION WELL BORING

After completion of the test boring, a 16-inch bore hole will be advanced to top of bedrock using standard cable-tool drilling techniques (FP 5-8). Fresh potable water may be used as a drilling fluid if needed while advancing the borehole to the water table. If potable water is used during drilling or the installation of the extraction well(s), representative samples will be collected and analyzed for VOCs. In addition, the volume of water used will be documented in the field notebooks and in the driller's log. The use of any drilling fluid additive is prohibited. All cuttings and water will be handled as outlined in Section 3.1.

4.3 EXTRACTION WELL INSTALLATION

The well will be designed and constructed using 12-inch pipe-size, continuous-slot, wire-wound 304-stainless-steel screen. The entire thickness of

the water-bearing zone above bedrock will be screened. Estimated screen length is 80 feet. Slot size will be determined from the grain-size distribution information collected during sampling of the test boring. Using the lithologic log from the test boring, zones with high clay content (as determined by the engineer/geologist based on grain-size analyses) will be blanked out using 12-inch-diameter 304-stainless-steel pipe. Screen size and gravel-pack material will be chosen that will retain a minimum 60 percent of the natural formation. The well will be completed above grade with a tower and platform for all electrical controls and pump motors. Mean sea level elevation of the platform floor will be 809.7 feet for the well (EW-1) located near well cluster CW-5. Other wells will be located at a similar elevation that will be determined when the location is identified. Figure 4.1 shows general well construction and completion details.

Well Filter Installations

A. An artificial filter material shall be installed within the annular space between the well screen and the temporary drive casings. Grain-size analyses of the filter material shall meet the following requirements:

   a. the uniformity coefficient shall not exceed 2.5

   b. the slot size of the well screen shall retain at least 90 percent of the filter material, and

   c. the grain size analyses shall be approved by the engineer/geologist prior to installation.

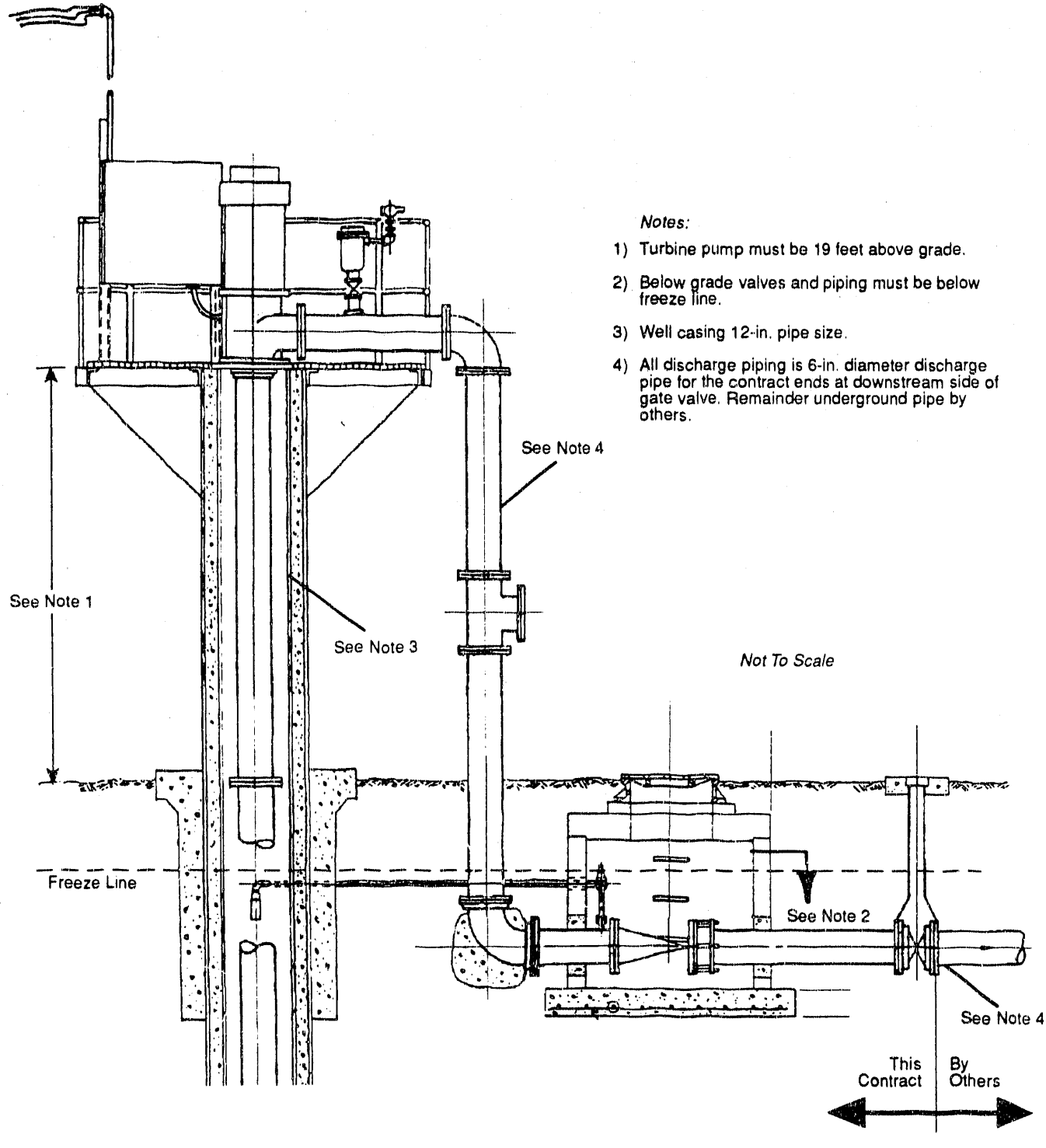
B. The filter material shall consist of a rounded silica gravel and extend from a point 2 feet below the bottom of the well screen to a point 2 feet above the top of the screen.

C. The filter material shall be placed by use of a tremie pipe lowered to the bottom of the space to be packed and slowly raised as the material is placed. Water shall be pumped in with the filter material.

D. During filter material placement, the temporary casing will be backed out.

Well Plumbness and Alignment

A. The completed wells shall be sufficiently plumb and straight such that there is no interference with installation of the permanent well pumps.



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DRAWING BY

CHECKED BY

APPROVED BY

5/9/91

5/9/91

FIGURE 4.1.

Typical Above Grade Completion

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B. The maximum allowable horizontal deviation of the well from the vertical shall not exceed 4 inches per 100 feet of depth.

C. Should the plumbness fail to meet the specifications described above, the plumbness and alignment shall be corrected by the Contractor at his/her own expense.

4.4 WELL DEVELOPMENT

The extraction wells are to be thoroughly developed to remove all sand and cuttings resulting from drilling and to also remove natural fine sands, silt or clays in the formation adjacent to the well screen. To minimize the amount of water that will require disposal, development will be in two stages. The well will first be developed using surge and bailing (FP 5-5). This will be continued until sand and heavy sediment has been removed. The second stage will be by pumping (FP 5-6) and will take place after the treatment unit is ready for use. The well development will continue until maximum clear discharge is achieved.

4.5 PUMP AND DISCHARGE

A temporary turbine pump will be provided for each well. The pump will be capable of delivering 800 gpm with a differential head of 70 feet, and transferring water through a 6-inch diameter line 500 feet (laterally) to the treatment system. Pump motor will be 440-volt 3-phase with electrical service provided to the well tower. It is estimated that the temporary pump will be in service for 2 months, while the system is being evaluated. At that time a proper size pump, estimated to be 200 to 400 gpm, will be supplied by the drilling contractor and installed in accordance with manufacturer's instructions.

4.6 FINAL WELL AND PUMP TOWER DESIGN

The drilling contractor will provide Detailed Design Drawings for the tower and valve pit within 10 days after award of this contract.

APPENDIX D

DESIGN PACKAGE 4

INSTALLATION RESTORATION PROGRAM

ENVIRONMENTAL INVESTIGATION OF GROUND WATER CONTAMINATION AT WRIGHT-PATTERSON AIR FORCE BASE, OHIO

DESIGN PACKAGE 4
MONITORING WELL INSTRUMENTATION

Submitted by:

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MAY 21, 1991
(REVISED JANUARY 1992)

ACRONYMS

CFR	Code of Federal Regulations
CPC	Central Processing Computer
CW	Cluster Well
ft	Foot or Feet
FS	Feasibility Study
HSP	Health and Safety Plan
IRP	Installation Restoration Program
l	Liter
mg	Milligram
NGVD	National Geodetic Vertical Datum
OEPA	Ohio Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
PC	Personal Computer
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
WP	Work Plan
WPAFB	Wright-Patterson Air Force Base

CONTENTS

FIGURES

TABLE

1.0 INTRODUCTION

This Monitoring Well Instrumentation Design provides the description and specifications for an automated ground water level monitoring system to be installed in conjunction with a removal action at Wright-Patterson Air Force Base (WPAFB), Ohio. The removal action is being accomplished under the Installation Restoration Program (IRP) at WPAFB in accordance with the Administrative Orders of Consent issued by the Ohio Environmental Protection Agency (OEPA). The purpose of the removal action is to prevent, to the extent practicable, the migration of contaminated ground water across the southwestern boundary of Area C at WPAFB. As determined through a focused feasibility study, the removal action will consist of a ground water extraction, treatment, and discharge system along a designated portion of the southwestern boundary of Area C.

2.0 OBJECTIVE

The objective of the monitoring well instrumentation network is to provide sufficient information on water levels in the anticipated zone of capture to verify the efficacy of the ground water extraction system. To provide the necessary data, 26 existing monitoring wells will be equipped with pressure transducers connected through a communications network to a data recorder and central processor. If necessary, additional monitoring wells will be installed (by others) in designated areas with instrumentation provided as described in this design package.

3.0 DESCRIPTION OF MONITORING WELL NETWORK

The 26 existing monitoring wells that will be used to establish the network are shown in Figure 3.1. The specific well designations, elevations - national geodetic vertical datum (NGVD), total depths, and depth to water are shown in Table 3.1. Eleven of the designated wells (in cluster wells [CW] CW-4, CW-5, CW-6, CW-7, and CW-8) were installed during the limited field investigation conducted under Phase I of the WPAFB project. Five other wells (HD-10D, HD-11, HD-12M, HD-13S, and HD-14S) belong to the City of Dayton. The remaining wells were installed during earlier phases of the IRP.

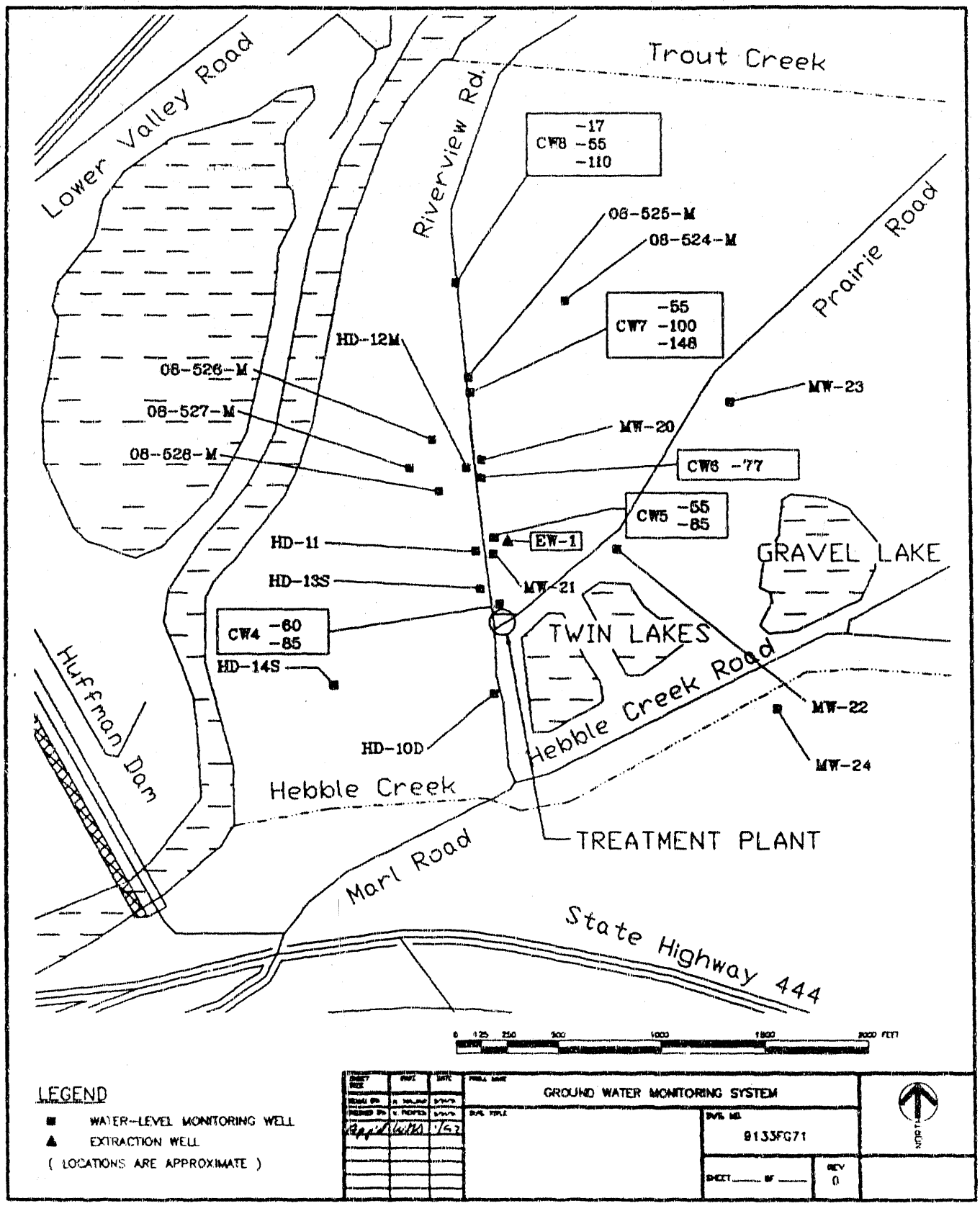

FIGURE 3.1. Monitoring Well Locations

TABLE 3.1. Monitoring Well Information

Well	Top of Well Casing Elevation (NGVD)	Total well depth (ft)	Depth to water (ft)[a]
CW4-60	792.07	60	13
CW4-85	790.08	84	11
CW5-55	793.59	55	15
CW5-85	793.85	85	15
CW6-77	790.67	77	14
CW7-55	791.79	55	10
CW7-100	791.69	100	9
CW7-148	791.78	148	10
CW8-17[b]	788.21	17	11
CW8-55[b]	787.91	55	10
CW8-110[b]	786.81	110	9
MW-20	791.12	21	12
MW-21	791.00	23	12
MW-22	796.24	36	16
MW-23	791.94	34	7
MW-24	796.24	12.5	10
HD-10D	793.24[c]	69.5	15
HD-11	791.86[c]	81.5	13
HD-12M	792.46[c]	54.5	14
HD-13S	789.55[c]	33	11
HD-14S	790.94[c]	33	13
08-524-M	790.80	15	6
08-525-M	792.60	16	10
08-526-M	791.50	16.4	12
08-527-M	789.90	16	10
08-528-M	791.30	17.5	12

[a] Approximate depth below ground surface based on October 1, 1990 data.
[b] Top of casing elevations are under review.
[c] Reference elevations for these wells are approximate.

4.0 GENERAL CONDITIONS

The information below is summarized from the Phase II Work Plan (WP) and Health and Safety Plan (HSP), which are included in these specifications by reference. The site is accessible by conventional and four-wheel drive vehicles. Vehicles will be required to enter and exit at WPAFB Gate 15A.

4.1 MATERIAL HANDLING AND STORAGE

An onsite material staging area will be provided. All material and equipment not in use will be maintained and protected from the elements at this location (Figure 4.1). The staging area will be maintained in an orderly manner at all times.

4.2 CERTIFICATIONS AND PERMITS

All personnel working onsite will have completed the Occupational Safety and Health Administration (OSHA) 40-hour safety training for work at uncontrolled hazardous waste sites and currently be a part of a medical monitoring program that meets the requirements of 29 Code of Federal Regulations (CFR) 1910.120. Copies of training certificates and proof of medical monitoring will be furnished by the contractor, if requested.

4.3 HEALTH AND SAFETY

While some contaminants may be encountered during onsite work, it is believed that the work will be performed under Level "D" as described in the Phase II HSP.

4.4 EQUIPMENT DECONTAMINATION

The downhole equipment will be decontaminated prior to installation. The decontamination area will be provided.

Decontamination procedures will follow those outlined in the Remedial Investigation/Feasibility Study (RI/FS) Quality Assurance Project Plan (QAPP) Section 8.0 and are as follows:

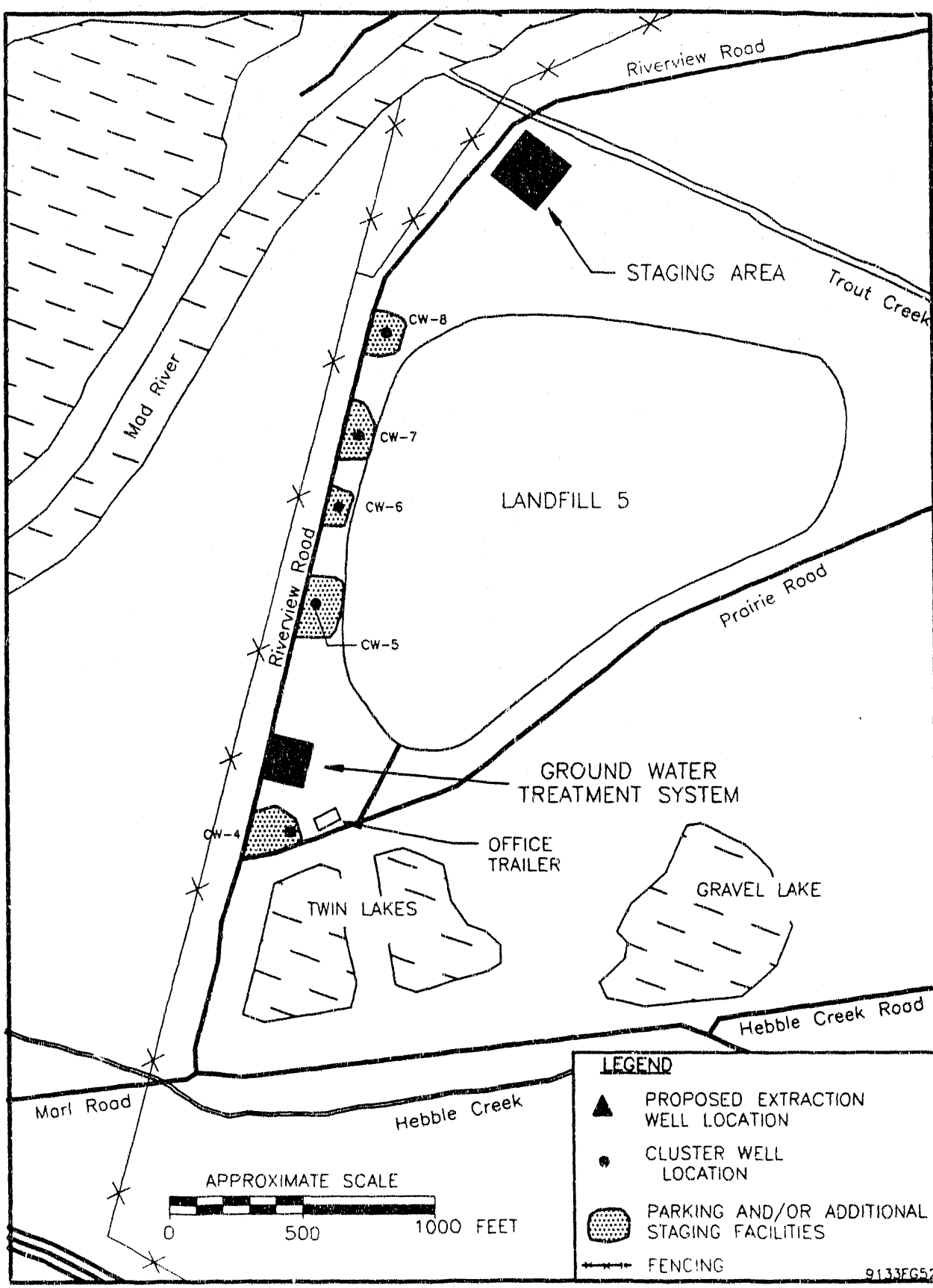

FIGURE 4.1. General Site Map

- Washing with potable water and a nonphosphate laboratory-grade detergent.
- Rinsing with potable water.

5.0 SYSTEM SPECIFICATIONS

The automated water level recording system shall be composed of four basic components: 1) pressure transducer; 2) data recorder; 3) communication system; and 4) central processing computer (CPC). The following sections present the minimum system performance specifications. Detailed specifications shall be supplied by the bidder.

5.1 PRESSURE TRANSDUCER

Each of the 26 monitoring wells shall be equipped with a pressure transducer capable of measuring water level fluctuations in 2-inch diameter wells. Refer to Table 4.1 for well elevation and water level information. Anticipated water-level fluctuations range from zero to 30 feet. Water in the wells may contain up to 1 mg/l of chlorinated volatile organic compounds (e.g., trichloroethene, perchloroethene, etc.) and may be slightly turbid.

The wells will also be equipped with dedicated pumping devices for sampling purposes (to be supplied by another contractor). Transducer operation should not interfere with sampling devices.

The transducer shall be stainless steel having a milli-amp or milli-volt per volt output operating with a excitation voltage between 10 and 30 volts. It shall have a linearity of 1 percent of full scale or better and a sensitivity of 0.01 foot.

Each of the wells shall be secured with a locking cap upon completion of transducer installation.

5.2 DATA RECORDER

Each transducer shall be connected to a data recording device. The recorder shall be high performance, and capable of use at remote, unattended environmental sites. Some locations may be subject to flooding. The data recorder shall be equipped with internal power (with 4 month minimum life) and capable of operating with external power.

A variable recording capability is required ranging from one reading per second to one reading per week. Recorded data shall be stored on site using a

central data communication device for transmission to the central processing computer. The system shall be programmable, with an alarm function that permits selection and identification of critical water level conditions.

5.3 COMMUNICATIONS SYSTEM

The on-site data storage system shall be capable of transmitting real time data to an off-site central processing computer. The central data storage system and all communications equipment will be located within the treatment system control room (Figure 3.1). Due to the remote well site locations and WPAFB limitations on use of radio communications, the communication system shall be by standard telephone-type land line.

The communication lines shall be buried below grade at a suggested depth of 36 inches. Identification markers shall be placed along the lines at a minimum distance of every 250 feet.

5.4 CENTRAL PROCESSING COMPUTER

A CPC shall be provided for off-site use and a portable computer interface should be installed at the ground water treatment plant. The contractor shall provide both computers. At a minimum each CPC shall be compatible with a personal computer (PC) and contain the necessary hardware and software to be capable of the following functions:

- Communication with data recorders
- Database management
- Printed output
- Tabular interpretation and screen display of data.
- Graphical interpretation (including contouring) and screen display of data
- Communication with off-site computers

The CPC shall have a hard disk drive and be capable of storage of data on high density floppy disks.

The data system should include an alarm function to communicate critical conditions to the off-site computer and capable of initiation of an emergency call.

APPENDIX E

DESIGN PACKAGE 5

Design Package 5 is incorporated by reference but is not included because of its size. Copies of this design package are available upon request.

END

DATE FILMED

11/23/92